Measurements of the Apparent Solar Diameter with Astrolabe at Observatório Nacional - 1997/2000

A.H. Andrei et al.
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Observations of the solar diameter are affected by a number of experimental difficulties. The metrological qualities of the astrolabe have rendered the modified CCD solar astrolabe a very reliable instrument for these measurements. The average value for the solar semi-diameter measured at O.N. is 959".16 $\pm$ 0".01, for λ= $563.5nm$, and an effective bandpass of $168nm$

To improve the signal to noise ratio, the images are treated for flat field. This includes distortions brought about by the COHU 4710 camera, the astrolabe optics, and by the system of filters used to cut down the incoming solar light. All frames are taken with constant integration time ($0.2sec$), thus dark current effects are taken into account in the flat field mask. IRAF routines are used, while complementary procedures were developed by the authors.

The extensive series observed (more than 12000 independent measures) is examined as a time series, using different methods, such as CLEAN and Fourier series, in order to check for the robustness of the answers. The prevalent conditions during the measurements are analyzed and their importance for the quality of the results is discussed. Conclusions are drawn about the statistical significance of the periodicities and features found.

Co−authors: E. Reis Neto, J.L. Penna, S.P. Puliaev, W.G. de Almeida, V.A. d'Ávila & E.G. Jilinski

Neutrino spin flip in system of magnetic barriers

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If a neutrino has a non-vanishing magnetic moment it's helicity can be flipped when it passes through a region with a magnetic field which has a component perpendicular to the direction of motion of the neutrino.

We have explored the tunneling of a relativistic neutral spin 1/2 particle (Dirac neutrino) through a finite number of magnetic barriers (wells). Using transfer matrix tehnique we have calculated the transmission coefficients and polarization phase change as a function of the incident angle and energy of the particle. For massles relativistic particle reflections accurs only in the case of non-zero incident angle.

Asteroseismology of roAp stars

L. Bigot et al.
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We present effects of a strong magnetic field and rotation on the properties of oscillations in roAp stars. The magnetic field is treated in a non-perturbative way in a thin layer at the surface of the star. For the rotation, both Coriolis force and centrifugal distortion of the star are taken into account. The oblique pulsator model is then use to infer some parameters of these stars.

Structure and dynamics of Procyon A by a seismological approach

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The success of helioseismology has spurred investigators to search for similar oscillations in other Sun-like stars and extend this diagnostic technique to become "asteroseismology". In anticipation of data that several planned space missions, including MONS satellite (Measuring Oscillations in Nearby Stars), will be soon devoted to provide, we consider the theoretical prediction of the power spectrum of oscillations of Procyon A, which shows solar-type pulsations, comparing models computed by taking into account an overshooting from the convective core, as well as a diffusion of helium and heavy-elements. We also calculate the frequency modification due to a given internal rotational behaviour, in order to examine the potential of asteroseismology to recognize, and with which accuracy, the possible signature of differential rotation.

A new estimation of global p-mode frequencies and splitting from the IRIS network data

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The IRIS network has accumulated low-l modes data since July, 1989, i.e. one complete solar cycle. Since the last publication of a frequency table (in 1997) the IRIS data bank was not only filled with new data, but also has been supplemented with data from other helioseismology instruments, through cooperative programs. The results of a new estimations of frequencies and splitting obtained with the resulting increase of the global duty cycle, as well as their variation along the solar magnetic activity cycle will be presented.

Co-autors: A. Serebryanskiy, E. Fossat and the IRIS team

MDI-SOHO Measures of Solar Radius Variation

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Why does the solar luminosity vary and could it change on human timescales by enough to affect terrestrial climate? As important as these questions are, we lack answers because we do not understand the physical mechanisms which are responsible for the solar irradiance cycle. Progress here depends on discovering how changes in the solar interior affect energy flow from the radiative and convection zones out through the photosphere. Measurements of small changes in the solar radius are a critical probe of the Sun's interior stratification and can tell us how and where the solar luminosity is gated or stored. Here we report results from a sensitive 3 year satellite experiment designed to detect solar diameter fluctuations.

Co-Authors : J.R. Kuhn, R. I. Bush, P.Scherrer

Total Solar Irradiance Increase into Solar Cycle 23

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Total solar irradiance (TSI) observations show a very short solar minimum in early 1996. The increase of TSI starts well before those of other activity parameters such as the magnetic field or the MgII index. Thus the onset of solar cycle 23 seems to be quite different from the last one in 1987. Models based on PSI and MgII-Index are unable to explain this behaviour whereas they accounted for over 90% of the variance over the period of the minimum in the 1985-87 time frame followed by the increase into cycle 22. Possible explanations for this behaviour are proposed.

New insights in sounding solar interior

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The solar limb is potentially a sharp spatial reference with which we can detect the effects of solar oscillations (both pression and gravitation modes), the quadrupole moment -and higher moments if any-, the true shape of the helioid (the oblateness at a first approximation), and changes in the solar radius. It is shown, in this paper, that the accurate determination of the successive differential gravitational moments are useful to probe the solar interior. We emphasize the main reasons, mainly, the accurate determination of the planetary orbits and the adjustment of the Eddigton-Robertson coefficient in the PPN gravitational theory. Moreover, both the shape and the radius measurements of the Sun help to determine the solar luminosity, as empirical models of total irradiance (solely based on magnetic effects) can not explain all aspects of irradiance changes. A complete theory is still pending. The space mission Picard, currently scheduled for end-2002 and under construction, will lead to validate our differential theory .

Generalization of a mixing-length model for nonradially pulsating stars

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Convection models based on the mixing-length approach still represent the main method for computing the turbulent fluxes in stars with convectively unstable layers. In such layers the pulsationally stability of the star is affected not only by the radiative heat flux but also by both the modulation of the convective heat flux and by direct mechanical coupling of the pulsation with the convective motion via the Reynolds stresses. Time-dependent formulations of the mixing-length approach for radial pulsation have been proposed for example, by Unno (1967) and Gough (1977). Using Gough's model Balmforth (1992) reported good agreement between theoretical damping rates of radial p modes of a solar model and observed linewidths.

In this contribution we discuss a generalization of Gough's time-dependent mixing-length formulation for nonradial pulsation. The pulsation is described by a time-dependent mean flow. The lateral component of this mean flow represents a shearing motion in the linearized fluctuation equations. The shearing motion stretches the convective elements and generates off-diagonal terms in the Reynolds stress tensor. In this description another parameter, additional to the mixing-length parameter, is introduced representing the angle between the lateral components of the mean flow and of the wave vector characterizing the convective element.

Wave number of dynamo-waves and modes of the global magnetic field of the sun (excited by $\alpha\Omega$-process in the convection zone)

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In the mixture-length approach the values of number $K\lambda$ (K is the wave number of dynamo-wave, λ is the characteristic scale of the dynamo region) near the bottom of the solar convection zone are calculated. In the turbulent dynamo model this number determines the character of the modes of the global magnetic field excited by mechanism which is based on the joint action of mean helical turbulence and differential rotation of the Sun. Using the our estimate of the helicity parameter and the values of the radial gradient of angular velocity obtained from the newer helioseismic measurements it is find out that on the certain phase of the solar cycle at low latitudes this mechanism produces rather the main antisymmetric (odd) mode of poloidal field, the dipole ($K\lambda \simeq -6,7$), while at the latitudes higher 40° the conditions are more favourable for exciting of the lowest symmetric (even) mode of field, the quadrupole ($K\lambda \simeq +7,2$).

First Results from the GONG+ Network

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The Global Oscillation Network Group has been obtaining helioseismic data from a six-station network for four years with an overall duty cycle of $\approx 90\%$ and will continue observing for a full-solar cycle. The initial, 256^2 rectangular pixel detectors have just been replaced with 1024^2 square pixel ones, and we will present the first results with the new system. In addition to enabling, high quality, continuous local helioseismology and probing closer to the surface, the GONG+ system provides continuous magnetograms, and offers the possibility of observing with a cadence as short as 16 seconds.

Search for p-mode frequencies on Procyon A from 1997, 1998 and 1999 velocity observations

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Following the recent evidence for the presence of an excess of power around 1 mHz in the frequency spectrum of the Doppler shift measurements for Procyon (Martic et al., 1999), we searched for individual frequencies of p-modes from three independent observing runs (5, 10 and 15 nights). All observations (Decembre 1997, Novembre 1998, January 1999) were made with the ELODIE fibre-fed cross-dispersed echelle spectrograph on the 1.93 m telescope at Observatoire de Haute Provence. The individual peaks in clean spectra of each time series in the interval of excess power are compared with the predicted p-mode frequencies from stellar models (Chaboyer et al., 1999) for Procyon A.

Spectral analysis of solar diameter measurements recorded at Calern Observatory astrolabe during two solar cycles

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Solar diameter measurements performed at Calern Observatory astrolabe during more than two solar cycles show temporal variations. However, due to seasonal effects and instrumental characteristics, recorded solar data are non uniformly sampled and have temporal gaps. Thus, monthly data were considered in all previous analysis of these solar data which limit found harmonic terms to a low frequency range. To determine short-term periodicities from the observed variations, daily solar data corrected from the zenithal distance are analyzed using special methods. In the present work, we use two methods to analyze the data. They are based on least square fits and deconvolution of the observation window function. Results deduced from the analysis confirm harmonic terms already found by other authors and reveal also new higher frequencies.

Co-authors: A. Irbah, E. Fossat , J. Borgnino, F. Laclare

Excitation and damping phenomenology and solar-cycle variations of low-degree p modes

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We consider in detail observed variations in the properties of low-degree (low-l) solar p modes over the solar activity cycle, as determined from the analysis of data collected by the Birmingham Solar-Oscillations Network (BiSON). Changes to the mode frequencies, damping rates and powers reflect variations in the characteristics of the surface layers of the Sun; in addition, information regarding the location and characteristics of the modal excitation source is coded in the complicated forms of resonant profiles. We shall discuss these issues in the context of the BiSON data.

Co-authors: *W. J. Chaplin, Y. Elsworth, G. R. Isaak*

Effects of hysteresis of some solar indices

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During the past two cycles, researchers have been monitoring solar irradiance at many selected wavelengths in addition to maintaining more traditional indices such as sunspot number and the 10.7cm flux. Certain pairs of these indices exhibit hysteresis, solar cycle dependent differences in their relative variations. We study this hysteresis effect by using smoothed time series of some indices of solar activity including the solar flare index and LDE flare index. The solar flare index and LDE flare index are newly calculated by the authors for the cycles 21 and 22. Further we try to find that hysteresis effect is indeed a feature of solar activity during the past two cycles.
Co-authors: T. Ataç and A. Antalova

Comparisons of Forward, Inverse Helioseismic and Diffusion Solar Models

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Published solar model element abundance profiles from an helioseismic solar model and a diffusion model are used in the author's solar structure program. The resulting models are compared with a standard model without diffusion and the author's high-Z core. Low degree and low order oscillation frequencies are compared with observed frequencies. In addition, relative model differences for speeds of sound, densities and gamma-1 functions are calculated and compared. It is shown that there are good agreements of relative differences between the seismic model and the high-Z core and diffusion models. But since the high-Z core model is the only model consistent with current solar neutrino experiment results, it is seen as the model closes to the real Sun.

Towards a Wave Theory Interpretation of Time-Distance Helioseismology Data

A.C. Birch et al.
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Time-distance helioseismology, which measures the time for acoustic waves to travel between points on the solar surface, has been used to study small-scale three-dimensional features in the sun, for example active regions, as well as large-scale features, for example meridional flow, that are not accessible by standard global helioseismology. The interpretation of travel times has typically been done in the ray approximation. The interaction of acoustic waves with features smaller than their wavelength, for example in active regions or in the tachocline, is not expected to be well represented by ray theory.

In order to develop a wave interpretation of time-distance data we employ the first Born approximation, which takes into account finite-wavelength effects and allows a single scattering between the source and receiver of the acoustic wave. We show the sensitivity of travel times to flows and structure perturbations and compare the results with ray theory.

Co-author: A.G. Kosovichev, Stanford University, USA

Spatially-resolved Analysis of the Upper Convection-Zone

R. S. Bogart et al.
Stanford University

Plane-wave (ring-diagram) analysis of high-degree modes in data from the SOI/MDI instrument on SOHO permits us to determine spatial and temporal variations of the structure and dynamics of the upper convection zone, to a depth of about 0.1 solar radius below the photosphere.

The spatial resolution achieved with full-disc data is at least 15 heliographic degrees (180 Mm), and the temporal resolution is of order 1 day. Data useful for such analysis cover at least two full Carrington rotations in each year since 1996. Additional data with three times the spatial resolution over a small portion of the disc are available for shorter durations at various times. Analyses of the full-disc data from the earlier years have already revealed systematic patterns in the global meridional flow and flows associated with active regions during the early phase of the solar cycle. Here we report on variations and trends seen in the flows as the activity level of the cycle approaches maximum.

Co-authors: J. Schou, S. Basu, D. A. Haber, F. Hill

ON A RELATION BETWEEN THE SPECTRUM OF TURBULENCE AND THE SPECTRUM OF NOISE IT RADIATES

L.M.B.C. Campos
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The generation of sound by turbulence is represented by the Lighthill (1952) tensor, of which the main term is the Reynolds stresses. Thus the acoustic pressure depends on the two-point turbulent velocity correlation and the acoustic power on its four-point correlation. The space-time Fourier transform the latter is the four-point turbulence spectrum. The acoustic power spectrum of sound generated by turbulence, is calculated in terms of the four-point turbulence spectrum in general, and then simplified for incompressible, isotropic turbulence. The method of evaluation of acoustic radiation integrals involving multi-point turbulence spectra is demonstrated first by calculating the acoustic pressure from two-point turbulence spectra, and then applied to the calculation of acoustic power spectra from four-point turbulence spectra. The present results allow a prediction of the power spectrum of noise emitted by turbulence, using as input only the turbulence spectra. This is a distinct approach from the Corcos (1963) type schemes which use semi-empirical functions. On a relation between the spectrum of turbulence and the spectrum of noise it radiates.

ON A THREE-DIMENSIONAL LONG PERIOD NON SINUSOIDAL ALFVEN WAVES IN THE SOLAR

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Alfven waves are considered propagating in a radial external magnetic field, in the presence of an uniform radial mean flow. These conditions lead to a second-order convected Alfvén wave equation, for the velocity perturbation. The wave equation has a regular singularity at the critical layer, where the mean flow and Alfvén speeds are equal. The other two singularities are the center, which is a regular singularity, and the point-at-infinity, which is an irregular singularity. It is possible to reduce the differential equation to a Gaussian hypergeometric type, for which all three singularities are regular. Thus the wave field can be calculated exactly at all distances, for all values of dimensionless frequency and Alfvén number, including analytic continuation across the critical layer ; these solutions are illustrated, as plots of amplitude and phase of the wave field, versus radial distance, for various choices of boundary and or radiation conditions. It is shown that the critical layer reflects and absorbs waves, i.e. inside the critical layer waves propagate inward and outward, and outside the critical layer they propagate only outward; the wave spectrum does not vary much with distance up to the critical layer, where wave absorption is greater for higher frequencies. Outside the critical layer, the amplitude of the lower frequency waves decays faster, so that the spectrum evolves so as to re-emphasize the higher frequencies. Thus Alfvénic wave spectrum steepens towards higher frequencies, as observed in the solar wind.

Pumping of magnetic fields by stratified convection: End of the storage problem?

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A long standing issue in the theory of stellar dynamos is the problem of keeping the magnetic field within the convection zone long enough for the dynamo to operate: A magnetic flux rope is typically assumed to escape the convection zone in a month or so, while the dynamo is thought to operate on a longer time scale of decades.

We present results from three-dimensional numerical simulations, of the interaction of stratified over-turning solar-like convection with a large-scale magnetic field: By the very topology of stellar convection, even a formally super-equipartion field may be held down at the bottom of the convection zone, rendering the storage problem obsolete. This effect might also explain the observations of magnetically active but fully convective late type dwarf stars.

Several simulations have been performed, with both open and closed upper boundary conditions, as well as including differential rotation: Inclusion of an open upper boundary may lead to a considerable flux loss unless the boundary is placed close to the physical boundary.

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The influence of a buried magnetic field on p-modes

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The magnetic field considered to reside at the base of the convection zone is presumed to vary over the solar activity cycle. We examine the effect of such a buried magnetic layer on the properties of solar p-modes. Analytical and numerical solutions to the dispersion relation for these modes are presented. Frequency changes due to the stored magnetic field are found to be negligible in comparison with the low- and intermediate-degree frequency shifts reported over the solar activity cycle. Nonetheless, there are grounds for inferring the signature of such a buried field through examining shifts of various degree. The p-mode frequencies are increased proportionally to the square of the field strength at the base of the convection zone and depend upon the thickness of the magnetic layer.

Co-author: B. Roberts

Probing surface flows and magnetic fields with time-distance helioseismology

Gizon et al.
Stanford University, USA

Time-distance helioseismology, applied to surface gravity waves, has been shown to be a useful tool to study horizontal flows near the solar surface, and supergranulation in particular (Duvall & Gizon, 2000). Here, we present maps of horizontal flows and horizontal magnetic fields, in both quiet and active regions. Travel-time sensitivity kernels based on wave theory, as opposed to ray theory, are used in the inversions.

The local 5-min oscillations in granules and intergranular lanes: observations and theory.

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Differences in the amplitudes, phases and periods of the five-minute oscillations above granules and intergranular lanes are found to be well-described in a frame of a relatively simple model. We utilized a 3D snapshot of the theoretically computed time depended solar model atmosphere. We considered a vertical monochromatic wave propagation in a moving, isothermal medium. NLTE synthesis of a time series of the FeI 5324 Å line profiles in the model atmospheres from a horizontal cut of the snapshot was performed taking into account granular and oscillatory components of the velocity field. Observations of the FeI 5324 Å line in a quite solar disk center and our theoretical modeling lead to the similar results:

- Periods of oscillations in intergranular lanes are lower than in granules;
- Amplitudes of the velocity oscillations grow with the contrast of granulation. Amplitudes of the intensity oscillations are larger in intergranular lanes than in granules;
- Velocity oscillations at the lower levels of the atmosphere lead oscillations at the outer layers in intergranular lanes. In granules this phase shift is nearly zero.

The fact that our simple model describes the basics features of the oscillations above granules and intergranular lanes made us come to the conclusion that differences in those oscillations are caused mainly by variations of the physical conditions in these structures.

Effects of density stratification on the thermal convection in rotating spherical shell

K. Kusano et al.
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We develop a new numerical model of compressible convection using pseudo-spectral method, and investigate how the thermal convection in rotating spherical shell is affected by the change in density stratification. Numerical simulations are performed using three different density stratified equilibria, those are constructed by changing polytropic index. The density ratio between the bottom and the top of these equilibria is in the range of 2 to 10, and the Taylor number is fixed to 10^4. It is found that, when the Rayleigh number is slightly above the instability threshold, the convection structure is little changed by the difference of stratification, whereas, as the Rayleigh number is increased, the convection with strong stratification is subject to a different type of transition of solution from the case of weak stratification. In fact, even sign of the averaged kinetic helicity is changed from negative to positive in northern hemisphere as the density stratification is enhanced. The results indicate that the density stratification is most important element for the solar convection.

Improved MLT and its applications to solar models

Y. Li et al.
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The most uncertainties in present solar modeling lie in the treatment of convection. The MLT, which is the commonly adopted approach to determine the convective energy transport and temperature stratification, assumes that the convection cells are of the same size of the mixing length and move upon the drive of the buoyancy, and ignores some important properties of turbulence such as the tendency of approaching isotropy and distribution of kinetic energy among convection cells of different sizes. Based on turbulence models, we improve the MLT by incorporating the anisotropic degree and radiative dissipation rate, and investigate the effects of these improvements on solar models. It is found that different degree of anisotropy and radiative dissipation rate have considerable effects on the temperature stratification of the solar envelope.

Co-authors: *Y. Li & J.Y. Yang*

Prospects for Deep Interior Helioseismic Holography

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Holographic seismic imaging of low-degree acoustic noise opens new diagnostic prospects that are most encouraging. (1) Low-degree seismic holography is already giving us images of large magnetic regions on the far surface of the Sun, a utility with valuable space-weather forecasting and general synoptic applications. (2) Diffraction-limited imaging of low-degree noise over pupils covering most of the near solar hemisphere promises the most discriminating probe of the deep solar interior, such as the base of the convecton zone. (3) Earth-based seismic observations coordinated with seismic observations of the far side of the Sun at frequencies in the range 6–7 mHz would allow us to resolve the thermal and Doppler profile of the solar core with a resolution of 75 Mm. (4) The interaction of surface magnetic regions with seismic waves has a strong dependence on spherical harmonic degree. This remarkable property is highly suggestive of the basic mechanisms whereby magnetic regions absorb acoustic waves.

Co-author: D. C. Braun

Nonlinear Modeling of the Solar Tachocline

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Among the more remarkable discoveries of helioseismology is a narrow shear layer across which the internal solar rotation rate changes from an approximately 30 percent latitudinal variation in the convective envelope to nearly solid body rotation in the radiative interior. Although this shear layer, known as the solar tachocline, may extend into the convection zone, evidence suggests that it is centered in the overshoot region or perhaps deeper in the stably-stratified interior. It has been proposed that the strong radial shear in angular velocity which defines the tachocline can be attributed to rotationally-influenced, quasi-2D turbulence kept nearly horizontal by the stable stratification. However, the details of how this may or may not occur remain unclear, and sophisticated models of nonlinear tachocline dynamics are currently lacking. Particularly uncertain is the precise role played by axisymmetric circulations and magnetic fields. Furthermore, most existing models do not address temporal variations such as those which have been recently detected in helioseismic data. In this poster, we introduce a new, fully nonlinear tachocline model based on numerical simulations of stably-stratified, rotating turbulence in a thin spherical shell. Several preliminary results will be presented, with particular emphasis on the global-scale redistribution of angular momentum and potential vorticity and on the interaction between the mean and fluctuating velocity fields.

Photospheric flow fields and properties of embedded small-scale magnetic flux concentrations

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The association between the different scales of convection on the solar photosphere and the field strengths/flux contents of discrete magnetic flux elements are analysed using simultaneously recorded SOHO MDI high resolution intensity, velocity (Doppler) images and magnetograms. The convective flow patterns are mapped using the Local Correlation Tracking (LCT) algorithm. The locations and strengths of the flux elements with respect to the flow cells are shown to reflect the depths of the associated downflows. This property is in turn, in combination with results of calculations on the convective collapse process that forms strong field elements, used to derive some properties of the different scales of convection.
Co-authors: R.Srikanth and S.S.Hasan/Indian Institute of Astrophysics.

The effect of a steady flow and a chromospheric magnetic field on p- and f-modes

Y.A. Taroyan et al.
National Academy of Sciences, Armenia

The combined effect of a chromospheric uniform magnetic field and a photospheric steady flow on the p- and f-modes is evaluated theoretically for a simple model of the solar plasma. The introduced flow is parallel to the horizontal magnetic field. This model may serve as a first approximation to assess the effects of the observed highly dynamical solar interior (e.g., subsurface meridional flows, convective motion, etc.) especially for high degree l.

Frequency changes due to the magnetic atmosphere and the steady flow are derived analytically in the long wavelength limit and are detemined numerically for arbitrary wavelengths.

The results reveal the influence of flow on the p- and f-modes is more dominant than the influence of the atmospheric magnetic field for the small wavenumber limit. However for arbitrary wavelengths the effect of magnetic field might be stronger than frequency shifts caused by a steady flow.

The understanding of the effect of subsurface flows on the p- and f-modes might help us to contribute to the solution for the puzzle of helioseismic frequency shifts.

Co-authors: R. Erdélyi, Space & Atmosphere Research Center, Dept. of Applied Mathematics, University of Sheffield, UK.

Fractional Frequency Shifts of Local Helioseismic Modes With Magnetic Activity Using Ring-Diagram Analyses

J. Toomre et al.
JILA / Univ. of Colorado, Boulder

B.W. Hindman, D.A. Haber, J. Toomre, and R.S. Bogart

Using full-disk Doppler velocity data from SOI-MDI during the advancing solar cycle from 1996 through 1999, we have computed the local frequencies of high-degree p modes and f modes over a dense mosaic of localized regions of the sun using ring-diagram analysis. The motion of active regions as they rotate across the solar disk is well traced by changes in the frequencies. Active regions appear as locations of large positive frequency shifts. Depending on the radial order and wavenumber of the observed acoustic modes the frequency shifts can be as much as 10 to 30 microHz. Shifts of this amplitude are 20 to 60 times larger than the shifts in global acoustic oscillations.

The magnitude and frequency dependence of the large frequency shifts are consistent with those measured in global modes provided the local frequency shifts are averaged over the solar disk and are scaled to the appropriate wavenumber regimes. The frequency dependence of the shifts indicates that the physical phenomena inducing them is largely confined to the surface layers of the sun, although there is some indication that there may be a deeper structural component as well. These local area samplings may help to understand the restructuring of the near-surface layers of the convection zone by magnetic fields.

Subsurface Flows With Advancing Solar Cycle Using Dense-Pack Ring Diagram Analyses

J. Toomre et al.
JILA / Univ. of Colorado, Boulder

D.A. Haber, B.W. Hindman, J. Toomre, R.S. Bogart, F. Hill

Large-scale horizontal flows within the upper convection zone of the sun are analyzed using the helioseismic technique of ring-diagram analysis applied to data from SOI-MDI. We map the velocity field over a substantial fraction of the solar disk by carrying out local inversion analyses over a Dense-Pack mosaic of many overlapping sites. There are substantial changes in subsurface flows at any given site from one day to the next that appear to be of solar origin. Such mosaics are processed almost daily for at least two solar rotations during each of the MDI Dynamics Campaigns from 1996 through 1999.

We find that longitudinally-averaged zonal velocity possess bands of fast and slow flow. As the solar cycle progresses, the latitudes at which the fast bands occur migrate towards the equator and vary in their flow amplitudes. These bands are not symmetric about the solar equator, and their asymmetry changes with time. The average meridional flow for the years 1996 to 1998 is primarily poleward, reaching maxima in the two hemispheres at the latitudes at which the zonal fast belts occur. The latitudes of maximal meridional flow drift equatorward in time much as the zonal fast belts. However, in 1999, the meridional circulation in the northern hemisphere develops a two-celled structure with latitude, whereas in the southern hemisphere it remains single celled.

Flux Separation in Photospheric Magnetoconvection

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Numerical experiments on three-dimensional magnetoconvection in a stratified compressible layer yield results that can now be compared with the high resolution observations of granulation and intergranular magnetic fields obtained at La Palma, and related to the slender loops revealed by TRACE. As the imposed magnetic field strength is decreased there is a transition from small-scale plumes, in the magnetically dominated regime, to large-scale vigorous plumes when the field is dominated by the motion. In the intermediate regime magnetic flux separates from the motion, so that there are almost field-free regions, with clusters of vigorous plumes, surrounded by regions where the Lorentz force is strong enough to control the dynamics. There is a range of field strengths where either small-scale plumes or flux-separated solutions can persist, depending on initial conditions for the computation. The patterns revealed in these calculations can be related to convection in sunspot umbrae (where there is a strong vertical field, and the appearance of umbral dots, to the formation of plage regions and to the behaviour of intergranular fields in the quiet Sun. In the weak field limit, turbulent convection is able to act as a dynamo and to maintain a disordered field.

Helioseismic and Magnetic Effects of Solar Flares from SOHO Observations

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A detection by SOHO/MDI of helioseismic acoustic waves on the photosphere in a form of ripples caused by a X-class solar flare, as well as magnetic field variations associated with the similar X-ray solar flare revived an interest to the problem of energy transport in these active events from the corona into deeper atmosphere down to the photosphere. The shock waves resulting from a hydrodynamic response of a flaring atmosphere to electron beam injection were assumed to be a source of the observed acoustic waves in the solar interior. However, a comparison of theoretical models with the observations shows that such shocks may not deliver the momentum required to provide the observed amplitude of these waves. Furthermore, a detection of the wave-like variations of magnetic field in the photosphere associated with X-class flares and, also, accompanied by CMEs and well pronounced Moreton waves raised further questions about a depth of maximum energy deposition in solar flares. These discrepancies along with a very close temporal corelation between the X-ray and helioseismic wave onset time lead to a search for other possible mechanisms being able to deliver the energy and momentum to the lower chromosphere and photosphere, in particular, by energetic particles. The future observations of acoustic or magnetic waves with the high-cadence SOHO/MDI Dopplergrams and magnetograms and theoretical advances in the particle kinetics and flaring atmosphere dynamics can resolve this puzzle.

Long period waves in the polar plumes as observed by CDS

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We examine spectral time series of coronal line Mg IX 368 Å and transition region line O V 629 Å, observed with the Coronal Diagnostic Spectrometer (CDS) onboard the SOHO spacecraft. Primarily we were looking for intensity and velocity oscillations in polar plumes, however by chance we detected a giant macro-spicule at the limb and were able to follow its dynamical structure. Blue and red-shifted emission in the O V line indicates that it is probably a rotating twisted magnetic jet. Emission is also detected in the Mg IX 368 Å line, at a temperature of 1 million K. Both Fourier and wavelet transforms have been applied independently to the analysis of the oscillations in order to find the most reliable periods. We report here on the existence of long period oscillations in the polar plumes as observed in the O V 629 Å line. Our observations indicate the presence of compressional waves with periods of 20-25 minutes.

Flare eruptions in the ARs with the reversed helicity sign

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In the last decade observations have revealed that a hemispheric preference of net sign of helicity, or handedness, exists throughout the solar atmosphere—in the photosphere, the chrmosphere, the corona, and the solar wind. For the photosphere, more than 70% of active regions in the northern/southern hemisphere have negative/positive current helicity (α or H_c), which can be inferred using observed vector magnetograms. The purpose of this paper is to examine whether active regions that do not obey the helicity sign rule show more flare activity than normal active regions. Based on the Huairou dataset, we computed the current helicity for several hundreds of active regions and found that: (1) most of 72 active regions with the reversed helicity sign accompany with abundant flare activities; the active regions without flare occurrence amount to only 11% of all the reversed-sign regions, but more than 24% for the normal active regions; (2) the number of these reversed-sign active regions also reach the maximum around sunspot maximum, like other indicators of activity (such as the flare count); (3) there are relatively more active regions with the reversed helicity sign and strong flare activity occurred in the southern hemisphere than in the northern hemisphere; such a hemispheric asymmetry may be useful for understanding the physical conditions and processes deep below the Sun's visible sueface, or photosphere.

Active Longitudinal Structures of the Sun from MDI and EIT Observations

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Using data from the EIT and MDI instruments on SOHO and from Kitt Peak Observatory we have studied the non-axisymmetrical structure and dynamics of solar activity at different levels of the solar atmosphere. The data were reduced to synoptic maps of the photospheric magnetic field and coronal structures in the EUV lines: 171Å, 195Å, 284Å, and 304Å. In addition, the coronal temperature maps were obtained using the ration of the 171Åand 195Ålines. The results reveal long-living longitudinal structures in the photosphere and corona during the transition from Cycle 22 to 23 and the rising phase of Cycle 23. We have found the Hale magnetic field polarity reversal first occured at the active longitudes. Thus, the stable longitudinal structures play an important role in the mechanism of the solar cycle. These structures are also revealed in the large-scale structure of the corona. We study the relation between the magnetic and coronal longitudinal structures, and their role in formation of coronal holes. We discuss the relations between rotation of the longitudinal structures in the photosphere and corona and compare with the rotation rate of the solar interior using helioseismic data.

This work was carried out in the collaboration with J.T. Hoeksema, A.G. Kosovichev and P.H. Scherrer of Stanford University.

Magnetic Splitting of Molecular Lines in Sunspots

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A study of molecular lines in sunspots is of particular interest because of their high temperature and pressure sensitivity. Many of them are also magnetically sensitive, but this was not yet widely investigated. With high-resolution, high signal-to-noise Fourier spectroscopy in four Stokes parameters now available, the use of molecular lines for studying the structure of sunspots brings real gains. One is the extension of spot models, including magnetic field, up to layers, where atomic lines suffer from NLTE effects but molecules can still be treated in the LTE approximation. Equally important is the fact that since molecular lines are extremely temperature sensitive they can be used to probe the thermal and magnetic structure of the coolest parts of sunspots. We present calculations of splitting and the Stokes parameters for a number of molecular lines in the visible and near-infrared regions. Our first selections are the green system of MgH $A^2\Pi$–$X^2\Sigma$ and the TiO triplet α, γ' and γ systems as the most studied band systems in the sunspot spectrum. The calculations involve different regimes of the molecular Zeeman effect, up to the complete Paschen-Back effect for individual lines. We look for molecular lines which can be used along with atomic lines to derive magnetic, thermal and dynamic properties of the umbra.

Co-authors: C. Frutiger (Institut für Astronomie, ETHZ, Zürich, Switzerland) and S.K. Solanki (MPI Aeronomie, Katlenburg-Lindau, Germany).

Stellar Activity Cycles

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We give a summary of our recent results obtained with the technique of stellar surface imaging and from the analysis of long-term photometric observations. We show that long-lived nonaxisymmetric magnetic structures (active longitudes) are observed in different types of active stars. We discuss various indicators of the cyclic magnetic activity of stars and the Sun and suggest for a new tracer of cycles which is based on the periodic alternation of the active longitudes. Finally, we compare our results with the most recent magnetic dynamo calculations.

2D simulations of solar anemones

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Anemone active regions (also known as fountains) are known to exist in the solar atmosphere since the advent of space-based observations in the 1970s. Here we present a two-dimensional numerical simulation, where the magnetic field is initialised as an anemone structure tied to the photosphere. Alfvén waves are driven at the photosphere and allowed to move up into the anemone structure. The inhomogeneity of the magnetic field leads to efficient linear conversion of the Alfvén waves into upwardly fast magnetoacoustic waves accompanied by density fluctuations. Parametric studies of the effect were undertaken.

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The Observation and Study of Two Prominence Events in the Infrared

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This paper reports the infrared observation of two prominence events on Jan. 8, 1999 and Feb. 9, 1999 at H Paschen β 12818Å, H Bracket α 40512Å, and H Pfund β 46525Åusing the McMath Telescope. We scanned the spectrograph slit across the prominences parallel to the solar limb to obtain three-dimensional data cubes (two spatial dimensions and one spectral dimension). By fitting these observed lines, we can directly determine some important physical parameters such as Doppler width, the optical thickness at line center, and the line displacement. Combined with simultaneous observation of Balmer H_α, H_β, and K lines, the new results of structure and dynamics of limb prominence are presented. These results imply that these infrared lines can penetrate through the prominence and become the potential probe and tool of them, while H_α and H_β sense the prominence skin only.

Spectroscopic features in the EUV emission of a M8 flare observed by SUMER

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On May 9, 1999 a flare of size M8 occurred while SUMER obtained a spectral scan above the active region NOAA 8537 at the west limb. We recorded spectra during the pre-flare phase, at flare onset, and during the decay phase. More than 60 flare lines were observed during this event, which include Fe XVIII - Fe XXIII lines that provide evidence of 10^7 K plasmas. We also recorded lines from He-like ions, such as Ne IX, Na X, Mg XI or Si XIII. Accurate wavelength measurements of such lines are of interest in basic atomic physics studies. Using plasma diagnostic techniques, we investigated the temporal evolution of the electron densities and temperatures during the event. Since the spectra contain lines from many different elements, we were able to determine elemental abundances in the flaring plasma.

(Co-authors: E. Landi, U. Feldman, D. Innes, B. Dwivedi, K. Wilhelm)

Spectroscopic Signatures of a Flare Observed in a SUMER Time Series

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On 06 November 1999, SUMER (the Solar Ultraviolet Measurements of Emitted Radiation spectrometer on SOHO) observed a post-flare site above active region NOAA 8758 which was approaching the north-east limb. SUMER recorded a time series taken with a constant slit position and several spectral windows covering a wide temperature range (10 000 - 10 000 000 K), preceded and followed by contextual raster scans. During this operation, a flare of size C4.6 occurred in the observed region, also observed by the GOES 8 X-ray flux monitor, the SOHO/EIT imager and the YOHKOH/SXT instrument. All data sets have been coaligned. The temporal evolution seen in SUMER spectra is presented and compared with the other observations.

(Co-authors: W. Curdt, B. Dwivedi and K. Wilhelm)

Solar Active Region diagnostics with SOHO/CDS

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SOHO/CDS observations of active regions are presented. The relation between the structures as seen in the higher corona and those at lower heights, in the transition region and chromosphere, is studied. The potential of the CDS instrument for plasma diagnostics is fully exploited, applying various techniques to determine the plasma characteristics across the active regions. In particular, temperatures and densities in the corona and in the transition region are determined. Element abundances are also studied, with the use of a differential emission measure analysis.

The Magnetic Nonpotentiality of Solar Active Regions at the Beginning of Cycle 23

J.P. Dun et al.
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Using a 1995-1998 data set of vector magnetograms at the Huairou Solar Observing Station of Beijing Astronomical Observatory, the magnetic field flux, shear angle, vertical currents and nonpotential energy of 280 active regions were calculated. The evolution of these parameters, their relationship, and the relationship between these parameters and solar activity were analyzed. The patterns of these parameters were studied too. The initial results as following: (1) By comparing with the monthly mean sunspot number and other solar activity indexes, we found that the magnetic field flux and nonpotential energy have a good correlation with solar activity. (2) The vetical currents and shear angle increase slightly from 1995 to 1998. (3) The distribution of these parameters has asymmetry between the hemispheres.

Co-auther: *H.Q. Zhang, B.R. Zhang, R.F. Li*

Force free magnetic fields: cylindrical vs. toroidal geometry

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It is shown that the behaviour of force free magnetic fields is governed by the existence of a first integral of energy. We give its explicit expression and we identify the parametric space where these fields are ergodic or non-ergodic. We further compare results based on toroidal geometries with results based on cylindrical geometries, to show the modification due to toroidal curvature.

Co-auther: G.J.J. Botha, Queen's University, Belfast, UK

The 3D Parker Instability of a Horizontal Magnetic Field and the Formation of Arching Flux Tubes

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Bipolar magnetic regions on the solar surface are believed to correspond to the topmost portions of Ω-shaped arching flux tubes that have risen buoyantly from the base of the solar convection zone, where strong toroidal magnetic fields are generated by the dynamo process. The undular Parker instability is one of the likely mechanisms by which buoyant, arching flux tubes can develop from the toroidal magnetic field. In this talk, I present our recent 3-D simulations of the growth of the undular Parker instability in a horizontal magnetic layer with uni-directional field lines, embedded in an adiabatically-stratified polytropic atmosphere. We consider the limit of very high plasma β, representing the condition at the base of the solar convection zone. The simulations show that distinct arching flux tubes form, and that buoyancy grows exponentially at the apexes of the tubes as a result of the diverging flow of mass from the apexes to the troughs. Even though the initial magnetic field is untwisted, the difference in motion between the apexes and the troughs causes bending and braiding of the longitudinal field lines, whose restoring tension force improves the cohesion of the rising flux tubes in comparison to previous results from 2-D simulations of the rise of horizontal flux tubes.

Sigmoid structure and evolution:

S. E. Gibson et al.
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Sigmoidal regions have been shown to be precursors to some CMEs, exhibiting an "S"-shape for several days before an eruption, and in some cases returning to that shape after the eruption. It is possible that their characteristic shape indicates a twisted or helical magnetic structure, with a greater than usual eruptive potential. We present here an analysis of a sigmoid's 3-d structure and how it evolves in relation to its eruptive dynamics. We use data from the SOHO, TRACE, Yohkoh, BBSO, SOON, and MLSO telescopes of a sigmoidal active region passing across the solar disk (during the recent third "Whole Sun Month" campaign). While S-shapes are generally most apparent in soft X-rays, these observations show the S clearly at a range of wavelengths including those showing an associated S-shaped filament. We will compare the S-shapes seen in SXR and those seen in cooler lines in order to probe the sigmoid's 3-d density and temperature structure. Specifically, we will show a series of overlays of images at multiple wavelengths, and monitor the evolution of the region through a non-eruptive stage when the S-shaped filament was clearly visible, the disappearance of this filament coincident with brightening at a range of wavelengths, and the sigmoidal region at the limb. We will also consider the sigmoid's structure in relation to its extrapolated magnetic field. Co-authors: L. Fletcher, D. Alexander, D. Biesecker, J. Burkepile, G. Del Zanna, C. Mandrini, H. Mason, Y. Liu, N. Nitta, D. Pike, J. Qiu, K. Ko, B. Schmieder, B. Thompson.

Sunspot dynamics and the heating of coronal loops

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Co-authors: D. Alexander/LMSAL, USA and A. M. Rucklidge/Cambridge, UK

The sub-surface dynamics of the magnetic field in sunspots plays an important role in providing energy for heating the corona. available. We present results from a hybrid model of coronal loop heating and sunspot dynamics, which keeps the two regimes distinct but allows a "transfer of information" between them. Specifically, the dynamics of the magnetoconvection generates a Poynting flux which we assume provides the necessary energy to heat the coronal loops.

The sub-surface model used describes magnetoconvection in a 2D axisymmetric geometry and considers the time development of the overlying coronal field. This model diverges from the standard practice of assuming constant temperature and vertical magnetic field conditions at the top surface by adopting a radiative potential condition. Extrapolation of the surface boundary conditions results in a coronal field configuration filled with plasma heated to coronal temperatures by the Poynting flux entering the coronal volume. The time dependence in the coronal loops is assumed to proceed via a series of equilibria in which the temperature and density distributions are in quasi-static equilibrium.

This combination of a sunspot model heating input allows us to explore a broad class of heating paradigms.

Velocity structure in the photosphere in the vicinity of Hα-filament

B.A.Ioshpa et al.
IZMIRAN, Russia

The velocity fields in the photosphere in the vicinity of different types of Ha filaments are analyzed. This analysis is based on the measurements of the magnetic field and radial velocity in the photosphere under and near the filaments obtained with the aid of solar magnetograph and tachometer installed on IZMIRAN solar tower telescope. We have also used the data of SOHO, YOKHOH and other cosmic instruments. It is shown that the filaments usually lie above the photosphere blue shift regions (the regions of upward motion) often surrounded from both sides by the regions of downward motion. The upward velocity in the photosphere under the filaments is about 100-200 m/s. The relationship between the velocity field structure on the one hand and the type of the filament on another is considered. The existence of the upward motion of photospheric matter under the filaments may be essential from the point of view of the theories of the filament support and matter supply.

EUV Line Intensities and the Magnetic Field in Solar Active Regions

J. Ireland et al.
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The Coronal Diagnostic Spectrometer on SOHO carries out daily synoptic observations of the Sun, recording four EUV spectra : He I 584 Å, O V 630 Å, Mg IX 368 Å and Fe XVI 360 Å, over a 4 arcmin-wide strip along the solar central meridian. A study has been made of 55 active regions and bright points appearing in the CDS synoptic dataset in years 1996-1998. Using the CDS dataset and the MDI full disk magnetograms we study the correlation of the chromospheric, transition region and coronal emission with the photospheric magnetic field for meridional active regions, probing the relation between the radiative output and magnetic observables. We establish empirical, quantitative relations among intensities of different lines, and between intensities and the magnetic field flux. This work extends the study of Schrijver (1985, 1987) to a larger sample of active regions and different EUV lines. We discuss the implications of this study for coronal heating models.

Active Region Evolutions and Flare Activities : From the Photosphere to the Corona

T. T. Ishii et al.
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The formation process of magnetic shear is a key to understand the physical mechanism of solar flare occurrence. In order to examine such a process, we need observational data of active region evolution from the photosphere to the corona. In this paper, we study active region evolutions and its relation with flare activities, using H-alpha images obtained at Hida and Kwasan Observatories and white light images with Transition Region And Coronal Explorer (TRACE). We also use the Solar and Heliospheric Observatory (SOHO) / Michelson Doppler Imager (MDI) intensitygram and longitudinal magnetogram for investigation of photospheric structures of active regions. Coronal structures of the regions are studied by using extreme ultraviolet (EUV) images obtained with SOHO and TRACE.

We investigate the evolution of the several active regions. We mainly report the evolution of the active region NOAA 8948 (April 2000) and discuss the relation between evolutionary characteristics and its flare activities. Many H-alpha sub-flares and several X-ray (C- and M-class) flares occurred in this active region. We suggest that the flares are triggered by the magnetic flux emergence that forms new sunspots in the following part of the active region.

Co-authors: T. T. Takeuchi and H. Kurokawa

Zonal structure and meridional drift of large-scale solar magnetic fields

E.V. Ivanov et al.
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Digitized synoptic charts of the photospheric magnetic fields have been analyzed for the past 3 solar activity cycles (1969-1996). The zonal structure and cyclic evolution of large-scale solar magnetic fields were investigated using the calculated values of the radial,meridional, and azimuthal components of the solar magnetic field averaged over one Carrington rotation (CR). The time-latitude diagrams of all 6 parameters and their correlation analysis clearly revealed a zonal structure, two type of poleward meridional drift and variations of large-scale magnetic fields with quasi periods of 2-3 and 5-5.5 years. It is concluded that on the Sun we observe two different processes of the organization and redistribution of the magnetic fields, which are related to the magnetic field generation and their following redistribution in the process of emergence from the field generation region to the solar surface. It is supposed that this redistribution is caused by some external forces (presumably, by giant and supergiant convection in the convection zone).

Solar Observations at Submm-Waves

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We report on the recent installation of the new Solar Submillimeter Telescope(SST) at the El Leoncito site, located in the Argentinean Andes, and also show first observational results. The instrument consists of a radome-enclosed 1.5-m cassegrain reflector and a system of two radiometers at 405 GHz and four at 212 GHz. The SST observes the quiet Sun and solar bursts simultaneously at both submillimeter-wave frequencies with a sampling rate of 1 millisecond. Since SST has seen the "first light" in May 1999, nearly 45 hours of continuous tracking of solar active regions were collected during short campaigns which produced first evidence for solar activity. The project has been funded by the Brazilian agency FAPESP, receiving support from the Argentinean agency CONICET through their institutes CASLEO and IAFE and from IAP, University of Bern and the Swiss National Science Foundation

Co-authors: *A.Magun, H. Levato, M. Rovira, N. Kaempfer, E. Correia, J.E.R.Costa, C.G. Gimenez de Castro, J.-P. Raulin, A.V.R. Silva & A.Luedi*

The formation of G-band bright points I: Standard LTE modelling

D. Kiselman et al.
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Assuming LTE, we investigate the formation of the G band in models of quiet solar photosphere and a semiempirical flux-tube model (Briand & Solanki 1995). Preliminary results agree with observations of of G-band bright-point contrast, though this a sensitive function of the amount of scattered light in the observations. Thus LTE line modelling in models constructed under the LTE assumptions seems to fit observations. This does not, however, necessarily imply that LTE is valid here.

We also present LTE synthetic spectra of the same models for the full wavelength range from UV to IR. This serves to point out other promising pass bands for the observations of flux-tube structures.

Three dimensional MHD study of solar corona based on the magnetograph observations

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Magnetohydrodynamic (MHD) properties of active regions in solar corona is investigated by combining the numerical analysis technique and the vector magnetograph observations. First, we numerically construct the potential magnetic field of several major active regions, and compare them with the tangential component of the magnetic field observed by Solar Flare Telescope in National Astronomical Observatory of Japan. The results suggest us that the amount of gap between the observed field and the potential field is some measure relating to the magnitude of solar flares taking place there. Secondly, we develop the numerical model to construct the three dimensional (3D) nonlinear equilibria in active regions using the vector magnetic field observed by magnetograph. Furthermore, the MHD stability of the solar corona will be discussed based on the numerical calculations using the 3D equilibria as the initial condition.

A Survey of the Size-flux Relation for Pores and Spots

W. Li, G. X. Ai, H. N. Wang and S. D. Bao
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Using the vector magnetic field data from the Huairou Solar Observing Station of Beijing Astronomical Observatory, we study their size-flux relations for various magnetic elements identified as pores and spots. More than 1000 pores and spots which located near the central meridian are selected. The results show that there exists a nearly linear relation between the the magnetic flux and area of all elements. Such a relation may be useful for understanding the physical conditions and dynamical processes of magnetic flux tubes in the solar plasma during the sunspot's formation. In addition, their characteristic size is also given.

Magnetic Configuration and Evolution in a Solar Active Region

Y. Liu et al.
Beijing Astronomical Observatory, Beijing 100012, China

In the paper, we present results of the analysis of NOAA 8668, which was observed by space satellite (SOHO) and ground-based observatories (BBSO, Huairou), The daily observations at Huairou usually end before the time near the start-time of BBSO observation, so the magnetic field of this active region was observed successively. With the SOHO data, it offers us a good example of a region observed continuously from low to high solar atmosphere. Several flares and a sigmoid filament were observed in the active region, and we observed the sigmoid filament from its birth to disintegrating. We find the configuration of the solar magnetic of this active region changed quickly during the activity phenomena, and the heating of the active region loops maybe the results of magnetic reconnection, and the flares are due to reconnection between the pre-existing field and newly emerging flux.

Co-authors:*H.Q. Zhang*

Velocities in Sunspot Plumes

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We investigate the line-of-sight velocities in 50 sunspot regions, based on observations of ten or six EUV emission lines with the Coronal Diagnostic Spectrometer - CDS on the Solar and Heliospheric Observatory - SOHO. The position of the sunspots on the solar disk ranges from disk centre to locations close to the solar limb. Attention is given to the sunspot plumes, the most prominent features in the transition region intensity maps. More than half of the sunspots show downflows in the sunspot plumes that exceed 25 km s^{-1} at temperatures close to 300 000 K. The observations show that this downflow cannot be maintained by inflow from the corona. The downflow in the sunspot plumes appears to be maintained by gas at transition region temperatures, streaming in flow channels from locations well outside the sunspot. Although individual flow channels show significant changes during approximately 10 minutes, part of the velocity pattern remains unaltered for approximately one day. The velocity fields in the transition region and the chromosphere are compared and the siphon flow mechanism is confronted with the observations.

Co-authors: N. Brynildsen & O. Kjeldseth-Moe

Oscillations in sunspots and active regions

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We present results of a joint observing campaign of SOHO, TRACE and the VTT on Tenerife. Sunspots and their surroundings have been observed and their oscillatory behaviour studied in terms of a variety of parameters (like intensity, velocity and magnetic field). Power, phase and coherence spectra of a sequence taken on 12. Sept. 1999 in a large pore will be shown. The near—infrared polarimetric spectra give velocity v and magnetic field B oscillations in the photospheric layers of the pore. Intensity oscillations in the UV measured with TRACE show chromospheric dynamics of the pore and its surroundings.

Co-authors: H. Balthasar/AIP, Germany & M. Collados Vera/IAC, Spain

Construction of 3D image of Hα flares

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The construction of 3D image and its evolution of Hα flares is carried out using the serial centered and off-centered filtergrams of Hα flares in help of the newly developing line formation depth theory by us. Some of the physical parameters like the velocity field are inferred from the image evolution. The potentiality of this method is discussed.

SUMER/SoHO observations of long period oscillations in active region filament

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During the MEDOC campaign #4 (October 1999), we observed an active region filament with the SUMER/SoHO spectrometer. After a global description of the active region NOAA 8725 with several instruments on board SoHO, we present a Fourier analysis of SUMER long time observations. This analysis allows to detect oscillations in several ranges of periodicities : 6-20 min, 30-40 min, and 55-150 min. We discuss these periodicities in terms of Alfvén and magnetoacoustic waves obtained in filament models developped by different authors. New MEDOC campaign (May 2000) coordinated with THEMIS (Tenerife) observatory should allow to examine the problem more closely.

Co-authors : *J. Solomon, J.C.Vial*

The relationship between CMEs and prominence eruption from SOHO and Tenerife observations

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co-authors: Aulanier G./NRL, Delannee C./GSFC, van Driel-Gesztelyi L./Meudon, Simnett G./Birmingham, Wiik J.E./Oslo

From multi-wavelength studies of eruptions of prominences observed by Yohkoh, SoHO and ground-based observatories, we find a good correlation between prominence eruptions and CMEs (i.e. May 1 1996, Sept 25 1996, May 31 1997). Focusing our interest on their temporal relationship, we observe that it is not clear that filament eruption is prior to the CME. Nevertheless they are both signatures of destabilization of the global coronal magnetic field.

The magnetic configuration in the corona should involve the initial presence of a twisted flux tube. The eruption could be driven by a fast increase of the poloidal field in the flux tube or by photospheric shearing motions of the flux tube.

CDS UV brightenings explained by Quasi-Separatrices and Bald patchs in a S-shape active region

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co-authors: Fletcher L. (Glasgow), Mandrini C. and Lopez M. (Argentina), Démoulin P. (Meudon), Mason H. and Young P. (Cambridge), Nitta (Palo-alto)

We present multi-instrument observations of AR 8048, made between June 3 and June5 1997 as part of SoHO JOP033. This active region has a sigmoid-like global shape and undergoes transient erupting phenomena which releases the stored energy.

Using a force free field approach, we defined coronal magnetic field lines which fit with the observations. The large-scale magnetic field lines confirms the sigmoid characteristics of the active region. The study in 3D of the configuration explained where and how the energy is released at different places.

The Ne VI brightenings correspond to the location of tangent to the photosphere field lines, named "bald patch", they are localized in the low transition region and represent feet of field lines. The Si XII brightenings at coronal temperature are at the top of coronal loops joining quasi-separatrices.

Origin of Universal Correlation between Temperature and Emission Measure for Solar/Stellar Flares

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We present a theory to explain the observed universal correlation between flare temperature T and emission measure $EM = n^2V$ for solar and stellar flares (including solar microflares observed by Yohkoh as well as protostellar flares observed by ASCA), where n is the electron density and V is the volume. The theory is based on a magnetic reconnection model with heat conduction and chromospheric evaporation, assuming that the gas pressure of a flare loop is comparable to the magnetic pressure. This theory predicts the relation $EM \propto B^{-5}T^{17/2}$ which explains well the observed correlation between EM and T in the range of 6×10^6 K $< T < 10^8$ K and $10^{44} < EM < 10^{55}$ cm^{-3} from solar microflares to protostellar flares, if the magnetic field strength of a flare loop, B, is nearly constant for solar and stellar flares.

Resonant transmission of magneto-atmospheric waves in sunspots

J. Staude et al.
Astrophys. Inst. Potsdam, Germany

Oscillations of velocity and intensity, of the magnetic field in the photosphere as well, have been observed at all height levels of the atmosphere above sunspots from the photosphere up to the lower corona. We discuss the nonstationary behavior of intensity and velocity oscillations; they have been observed by SOHO in transition region lines formed in the EUV plume of a sunspot during a continuous time series of 4.3 hours. Applying a wavelet analysis, we find periods around 3 mHz with different periods in the observed EUV lines. Moreover, we discuss the observed oscillations within the frame of model calculations for the resonant transmission of magneto-atmospheric waves through realistic models of the sunspot subphotosphere and atmosphere.

Co-authors: *J. Rendtel & A. Settele*

Origin of Tilt Angle and Heliciy in Solar Active Region Magnetic Fields

L. Tian et al.
Beijing/National Astronomical Observatory, China

ABSTRACT: It is investigated that observed property of tilt angle of magnetic polarity axis and current helicity parameter $h_{||}$ for 203 active regions, in which bipolar magnetic fields are dominant, from data set of photosphere vector magneto- grams observed at Huairou Solar Observing Station of Beijing Astronomical observatory during the 22th active cycle. Some results are:

(1). It is related in sign between the tilt angle and current helicity parameter $h_{||}$ for 60% bipolar active regions, which have positive/negative tilt angles of magnetic polarity axis with negative/positive current helicity parameter $h_{||}$ in the northern /southern hemisphere, when the tilt angle and current helicity parameter are according to the regularity that others obtained before, respectively.

(2). It is correlated between variance of the tilt angles and current helicity parameters $h_{||}$ with the latitude for 138 'normal' bipolar active regions, which are accorded with Hale-Nichson Law.

(3). It is also correlated in quantity between variance of the tilt angles and current helicity parameters $h_{||}$ with the proceeding of active cycle for the 138 'normal' bipolar active regions.

Therefore, we deduce that tilt angle and current helicity are produced by Coriolis Force acting on a rising and swelling Ω flux tube in the convection zone.

Magnetic Field Reconstruction in a Solar Active Region

H. N. Wang et al.
Beijing Astronomical Observatory

It is widely believed that coronal structures delineate magnetic field lines anchored on the photospheric surface. Supposing coronal magnetic fields are in a force-free state from the chromosphere to the height of two solar radii, we reconstruct 3D force-free magnetic fields by making use of a new numerical technique, in which the fields are represented by a boundary integral equation based on a specific Green's function. Vector magnetic fields observed on the photospheric surface can be taken as the boundary conditions of this equation. In this numerical computation, the following two points are emphasized: (1) A new method for data reduction is proposed, for removing uncertainties in boundary data and determining the parameter in this Green's function, which is important for solving the boundary integral equation. In this method, the transverse components of the observed boundary field are calibrated with a linear force-free field model without changing their azimuth. (2) The computed 3-D fields satisfy the divergence-free and force-free conditions with high precision. The alignment of these field lines are in agreement with structures in H_α and Yohkoh soft X-ray images. Since the boundary data are calibrated with a linear force-free field model, the computed 3D magnetic filed can be regarded as a quasi-linear force-free field approximation. The reconstruction of 3D magnetic field in active region NOAA 7321 was taken as an example to quantitatively exhibit the capability of our new numerical technique.

Flare-CME Events in a Superactive Region

Jingxiu Wang et al.
National Astronomical Observatories,
Chinese Academy of Science

Flare-CME events in a superactive region, NOAA 8100, have been studied, using a data base that consists of photospheric vector magnetograms, Hα and Hβ filtergrams, SOHO EIT and LASCO, and Yohkoh SXT images. The following results are obtained. 1) There were 5 main emerging flux regions (EFRs) and several key sites of flux cancellation. The newly emerging flux and its driven flux cancellation were likely to result in the expansion of the large-scale flux loops, which became sigmoidal. 2) All flare-CME events were initiated at the narrow magnetic interface between a major EFR and its impacted higher magnetic loops. 3) Each event showed nearly simultaneous occurrences of the flare, dimming and CME in widely-separated areas. This indicates an energization of a globally connected large-scale loop system. Eruptions of giant solar magnetic loops seem to be responsible for extended CMEs.

Co-authors: J. Zhang/Beijing, Y. Liu/Stanford, N. Nitta/Palo Alto, G.L. Slater/Palo Alto

Evolution of the Filament and the Eruption of the Two-ribbon Flare on May 13, 1981

A. A. Xu et al.
Department of Astronomy, Nanjing University, China

Using the observational Hα, radio and X-ray data, we measure the ascending movement of the filament in the active region, and derive the current intensity and the current distribution inside the filament from its dynamic and energy equations. The comparison between the ascending filament and the position of the hard X-ray image shows that they are co-spacial. These results suggest that the physical process in the thermal and non-thermal phases of the flare could be explained respectively by the tearing instability occurred inside the filament and the revised Alfvén-Carlqvist current interruption theory. The theoretical calculations are basically consistent with the observations.

co-aurthors G. P. Wu, Y. H. Tang

On the solar burst event at 02:40UT on 20 Sep. 1998

Yihua Yan et al.
Beijing Astronomical Observatory, China

In this paper, the solar burst with 450 s.f.u. peack flux at 2840 MHz of September 20 1998 02:40 UT was observed at Beijing Observatory by "Solar Radio Broadband Spectrometer" with very high temporal resolutions of 8 ms in 2.6-3.8 GHz frequency range with spectral resolutions of 10 MHz. Space Observations from TRACE images showed a circular shell-shaped burst at the same time. The event is analyzed and discussed based on both ground and space observations so as to better understand the flare process.

Co-authors: *Q. Fu, Y. Liu, Z. Chen & H. Ji*

Solar flares and related coronal magnetic field structures

Yihua Yan
Beijing Astronomical Observatory, China

Coronal magnetic fields plays a central role in the solar flare process. It is believed that the flare is caused by fast releasing of pre-stored magnetic energy. However, until now it is still not clear what is the environment in which this energy release occurs? The rapid conversion of this energy into the kinetic energy of hot plasma and accelerated particles may in turn cause hazardous effects in interplanetary space. What are the characteristic radiation signatures of such flares and how do they occur and evolve? Extrapolation is presently the only way to reconstruct 3-d coronal field and radio methods provides almost the unique diagnosis of the coronal magnetic fields under certain assumptions. In this paper we study the associations between extrapolated 3-d coronal fields under non-constant-alpha force-free field and the flare process from ground and space observations.

Observation of reconnection inflow of a solar flare

T. Yokoyama et al.
National Astronomical Observatory, Japan

We found a piece of evidence of magnetic reconnection inflow in a flare on March 18, 1999. This is a flare occurred on the northeast limb that showed a nice cusp shape soft X-ray loop and a plasmoid ejection typical for the long-duration-events. The EUV observation of the same flare shows us a bubble-like void ejection. The core of this EUV void corresponds to the soft X-ray plasmoid. Moreover, as this void is ejected, magnetic reconnection occurs at the disconnecting point. And a clear ingoing pattern toward the magnetic X-point is seen. The inflow velocity is about 5 km/s. Based on this observation, we derived the reconnection rate to be $M_A = 0.007$, where M_A is a Alfven Mach number of the inflow. (Co-authors:K. Akita/Osaka Gakuin Univ., T. Morimoto, K. Inoue/Kyoto Univ., Japan & J. Newmark/NASA/GSFC, USA)

The Opening of EUV Loops

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We analyzed simultaneous H_α, H_β data from Huairou Solar Observing Station, EUV data from the Transition Region and Coronal Explorer, soft X-ray data from YOHKOH, radio data from NANCAY, and full-disk images from SOHO/MDI, EIT, and LASCO. In the active region NOAA 8375 we studied, we found that while opposite polarity satellite sunspots cancel each other, plage filaments erupt, and flares appear. Looking from EUV and soft X-ray images, we noticed that part of the EUV and X-ray loops open. Several hours later than the loops open, a halo coronal mass ejection happened observed from LASCO/C2. We suggested that the filament eruption and the opening of EUV loops are the causes of CME.

An Analysis of the Solar Rotation Velocity by Tracing Coronal Features

R.Brajša et al.
Hvar Observatory, Croatia

Co-authors: B. Vršnak[1], V. Ruždjak[1], D. Roša[2], D. Hržina[2], H. Wöhl[3], F. Clette[4], J.-F. Hochedez[4]

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Full-disc solar images in the extreme ultraviolet part of the spectrum from the SOHO spacecraft (EIT) are used to identify various coronal structures appropriate for the solar rotation determination (e.g. bright points and coronal holes). From the time differences in tracer positions (more than 1 image per day) solar rotation velocities are measured, primarily by well-defined tracers, such as coronal bright points, whose large number and broad coverage of latitudes may provide an unique opportunity for a solar rotation analysis. The analysis started using the SOHO data from 1997-1999 and preliminary experiences obtained measuring solar rotation from the full-disc images in soft X-rays from the YOHKOH (SXT) satellite were taken into account. This work is connected to the SOHO EIT Proposal Brajsa_206

Comparison of blinkers observed with CDS and with SUMER

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Blinkers are transient brightenings seen in the extreme ultraviolet. These brightenings are candidates for microflare activity. Here we determine their properties, using co-aligned observations with SUMER and CDS, in the latter case with an open slit.

We use CDS to find evidence for blinkers in the quiet Sun, and SUMER to measure the velocities, and line width changes associated with them.

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Computed vs Observed Lines Profiles of Metallic Atoms in Prominences

Cirigliano, D. et al.
IAFE, Argentina

In recent years several solar prominence models were developed to determine different physical parameters such as temperature, density and pressure along the modelled prominence structure. By solving simultaneously the radiative transfer and statistical equilibrium equations we compute lines profiles for the Ca II H and K lines, Mg II h and k lines and He I at 584,3 Å for several models given by the hydrogen atom. The prominence models differ in pressure (isobaric), temperature and width of the central core. The number of threads is also used as a free parameter. The computed profiles are compared with the observations made with the SUMER instrument on board SOHO and with the LPSP instrument on board the OSO 8 satellite in order to constrain the physical plasma parameters of solar prominences.

Cyclic Variation in Solar Temperature Minimum Region

C. Fang et al.
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CaII K line has been measured regularly nearly every month since 1974 at Kitt Peak. It is known that the K_1 component of the CaII K line is formed in the temperature minimum region (TMR) of the solar atmosphere. Our study on the data of CaII K line profiles over nearly two solar cycles indicates that both in full disc integrated spectra and in disc-center spectra, the distance between red K_1 and blue K_1 and its mean intensity show periodical variations, but the former fluctuates in the same way as the sunspot number does, while the later has a time delay with respect to the sunspot number. Non-LTE computation indicates a cyclic temperature variation of about 15 K of the TMR in the quiet-Sun atmosphere and a cyclic variation of about 15–20 km of the position of the TMR.

Co-authors: Y. X. Zhang, M. D. Ding, & W. C. Livingson

DEM Study of Selected Quiet Sun Areas

C. Gontikakis et al.
Research Center for Astronomy,Academy of Athens, Greece

In the present work EUV spectra of quiet Sun regions, observed with the Coronal Diagnostic Spectometer (CDS), are analysed in order to determine the Differential Emission Measure (DEM) of selected areas of the field of view. In particular, we study the differences between the DEM curves of the quiet Sun cell center areas, network areas and cell-network boundaries. The results are discussed in the light of theoretical models for the solar upper atmospheres.

Co-authors : E. Landi/Max Plank Institut für Aeronomie, Germany, H.C. Dara/Research Center for Astronomy and Applied Mathematics, Academy of Athens, Greece, C.E. Alissandrakis/Section of Astro-Geophysics, Departement of Physics, University of Ioannina, Greece, J.-C. Vial/Institut d'Astrophysique Spatiale, France

Magnetic Field Structure of the CME Source Region

Y. Hanaoka et al.
National Astronomical Observatory of Japan

The three-dimensional structure of the magnetic field in the source region of CMEs is the key to understand how the stored magnetic energy eventually causes an eruption. Particularly, a CME accompanied by a filament eruption on 2000 February 26-27 is a good event to study the three-dimensional magnetic field structure. This event was very well observed with SOHO/EIT and LASCO, Yohkoh, and the Nobeyama Radioheliograph. Based on the preliminary analysis, we found the following clues to study the 3-D magnetic field structure which causes the CME.
- The helical structure of the filament before the eruption is kept during the eruption up to about ten solar radii.
- The coronal loop structure shows that this event is an eruption of a part of the quadrapolar magnetic field structure consisting of two active regions.

In the meeting, we will discuss the presumed three-dimensional magnetic field of the CME source region.

Anomalous Line Shifts on the SOHO/CDS NIS Detector

S.V.H. Haugan
ESA Space Science Department

Observations with the SOHO/CDS NIS detector prior to the recovery of SOHO show strong correlations between line shifts and local intensity gradients along the slit. The most plausible explanation is an elliptical, tilted point spread function inducing anomalous line shifts. This must be taken into account when interpreting NIS observations with strong intensity gradients. The optical properties of SOHO/CDS changed quite significantly during the time period when SOHO was out of control. Initial results from a similar analysis of post-recovery data will also be presented.

Statistical study of solar eruptive events observaed with Nobeyama Radioheliograph at 17 GHz

K. Hori and K. Shibasaki
Nobeyama Radio Observatory, NAOJ

On the basis of microwave solar images from Nobeyama Radioheliograph (NoRH), we report on statistical features of solar eruptive events. In microwaves (17 GHz), most of eruptive events are originated from polar crown filament or far from active regions, and not associated with flares. This tendency, which is contrary to what seen in soft X-rays by Yohkoh/SXT, probably reflects a temperature dependency in this wavelength. By using 17GHz synoptic maps from NoRH, we discuss i) where the microwave eruptions tend to occur and ii) its spatial relation with magnetic structures above (e.g., streamers) that can be seen in LASCO coronagraph images.

The CME Observations at 232 MHz

L.S. Kang
Beijing Astronomical Observatory, CAS, China

In this paper we introduce CME observations with the meter-wave synthesis radio telescope of Beijing Astronomical Observatory at 232 MHz and discussiones of solar coronal mass ejection events which were measured by us last year.

Different Faces of Coronal Mass Ejections

M. Karovska et al.
Harvard-Smithsonian Center for Astrophysics, USA

We present results of our study of several coronal mass ejections (CMEs) observed on 1999 August 28 by the LASCO and EIT instruments onboard the Solar and Heliospheric Observatory. Three CMEs developed within several hours near the south-west limb, each presenting a different face of this eruptive phenomenon.

We used image processing techniques to enhance multi-scale structures in the CMEs. The enhanced images of the first CME show a particularly interesting feature - the presence of sinuous lines below the circular rim which suggest a helical magnetic field. The enhanced images of the second CME show several bright circular rims which can be interpreted as marking the apexes of expanding magnetic flux ropes. An X-class flare was associated with this CME. The third CME exhibits a three-part structure consisting of a bright leading edge, a dark cavity following the leading edge, and a compact bright region within the cavity.

We were able to track the structures of these CMEs from their origins near the surface of the Sun out to great distances and study their kinematics. Our results show that the acceleration takes place below heights of few solar radii and the velocity has leveled off as the CMEs reach the LASCO/C3.

Co-Authors: B. E. Wood (JILA), J. Chen, J. W. Cook, and R. A. Howard (Naval Research Laboratory)

Polar Coronal Rays Are Not Polar

Jing Li et al
Institute for Astronomy, University of Hawaii, Honolulu, USA

In this poster we discuss the nature of polar rays, based on limb synoptic images constructed from Yohkoh/SXT and SOHO/EIT data. In the literature, polar rays and polar plumes are often mentioned interchangably. We find that polar rays are projection effects caused by hot plasma from equatorial active areas and are not physically associated with the coronal polar holes. Instead, the rise in number and strength of polar rays toward solar activity maximum is responsible for hiding the polar holes and polar plumes. We will present the limb synoptic maps and simple physical models to lead to this result.

Co-authors: Barry LaBonte

The Probable Contribution of the Coronal Holes Periphral Structuresto the Coronal Mass Ejections

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The probable relation of 140 coronal mass ejections (CMEs) obtained by Satellite SMM in 1980, 1984, and 1989 and the periphral structures of coronal hiles, flares and eruption prominence events was analysed in this paper. The result shows that the relation of CME with the periphral structures of coronal holes is most close. CME with equatorial coronal holes have a synchronous long-range evolutional relation. Judging from this, it can't be ignored that the periphral structures of coronal holes are an important background factor for the occurrence of a CME.

Key words: CME; Periphral Structures of Coronal Holes; Relative Analyse

Plasma Parameters of a Prominence Observed on October 16/17, 1999 by SUMER and CDS/SOHO

M. S. Madjarska et al.
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The aim of our study was to confirm and enrich the results obtained so far on dynamics and diagnostics of solar prominences. A prominence observed on October 16/17, 1999 during MEDOC campaign # 4 in the frame of the updated joint observing programme 09 was studied. The main prominence plasma parameters like temperature and density were derived as well as their changes during 8 hours of observations. The relative line-of-sight velocities were obtained in the cool plasma material (SUMER, Si IV, 8 10^4 K) and prominence-corona transition region (SUMER, O IV, 2 10^5 K). Velocity and line width maps in both CDS He I 584 Å and O V 629.73 Å were derived. A study of the blend of O IV 1404.81 Å by Si IV 1404.77 Å and the second order line O III 702.31 Å was made.

(Co-authors: J.-C. Vial/Orsay, France)

Observations of electron density enhancement during an UV explosive event

M. S. Madjarska et al.
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High resolution temporal observations performed with the SUMER spectrometer on SOHO provide us the opportunity to investigate the electron density variations in the solar mid transition region due to explosive event–like phenomena. The O IV 1401.16/1404.81 density sensitive line intensity ratio shows a clear increase during a strong explosive event, corresponding to an electron density enhancement of a factor of ~ 3.5 respect to pre-event values. This is consistent with recent MHD simulations (2.5 D) carried out by Karpen et al. (1998).
Co-authors: J. G. Doyle and L. Teriaca

Karpen J.T., Antiochos S.K., DeVore C.R. and Golub L., 1998, ApJ 495, 491

EVER ACTIVE SUN!

V.N.Obridko
IZMIRAN, Russia

An up-to-date concept of solar activity was developed using ground-based data as well as satellite observations. According to this concept:

1) Solar activity manifests itself in various forms at all latitudes from the poles to the equator and at all space scales from several hundred to many hundred thousand km.

2) The active events are not confined to the relatively short periods of the 11-year maxima, but ocurr permanently in one or other form, including the minimum epochs of the 11-year cycle.

3) A certain parallelism exists between the local and large-scale (global) fields, so that most objects and phenomena in local fields have their analogy in global fields.

4) A number of geoeffective phenomena on and near the Earth, and in the heliosphere, that used to be entirely attributed to processes in the local fields, turn out to be determined to a much greater extent by processes in the large-scale structures.

5)It is shown that processes in the local fields follow processes in the global fields with a delay of 5-6 years.

Element Abundance in Different Corona Streamers

S. Parenti et al.
University of Central Lancashire, U.K.

Element abundance in equatorial and mid-latitude streamers have been derived from data taken by SOHO/CDS and UVCS experiments. Observations were made at 1.1, 1.5,1.6 $R_{\odot}$, to allow us to check a possible variation of elemental composition with altitude. Part of the CDS data were taken at the border of the south Corona Hole, so that the variation of coronal composition at the streamer edge is investigated.

UVCS spectra have been acquired using three different grating positions to cover lines from low and high First Ionization Potential. Absolute abundance of Oxygen and Iron have been determined via the evaluation of the radiat ive and collisional components of the H-Lyman β and O VI (1032 Å) lines and of th e intensities of lines from Fe X-XIII-XV-XVIII. Abundance of Fe, Si, Al, Mg were estimated using the Differential Emission Measure technique.

This method gives us information also on the plasma electron temperature (T_e), which is compared with temperatures estimates from line ratio technique. The variability of (T_e) and of abundances in the observed streamers are discussed and compared with estimates from the literature.

Statistical features of the Quiet Sun in EUV

A. Pauluhn et al.
HTA Bern and ETH Zürich, Switzerland

The frequency distribution of the extreme ultraviolet (EUV) intensities in the quiet Sun has in the past usually been modelled using two Gaussians. Here we test this and other distribution functions against observed distributions with exceptional statistics. The data were obtained in a number of spectral lines observed with two extreme ultraviolet spectrometers, CDS (Coronal Diagnostic Spectrometer) and SUMER (Solar Ultraviolet Measurements of Emitted Radiation) on board the Solar and Heliospheric Observatory (SOHO). We show that the frequency distribution of the radiance is best modelled by a lognormal distribution or by a sum of a lognormal and a Gaussian. The fact that the radiance distribution of the quiet Sun including the network and the intranetwork is better reproduced by a single lognormal distribution function than by two Gaussians suggests that the same heating processes are acting in both types of features. The shape of the distribution function shows a clear temperature dependence.

X-ray, EUV and UV counterparts of polar radio brightenings

S. Pohjolainen et al.
Observatoire de Paris, Meudon, France

Radio brightenings near the solar poles have recently been detected at 87 GHz (3.5 mm). Some coronal holes are seen as radio bright, but no uniform brightness exist over the holes in 3.5 mm. Comparison to Yohkoh/SXT, SOHO/EIT and TRACE data have revealed counterparts like bright points, polar plumes, and diffuse EUV brightenings to the local radio bright regions.

Calculations using previously published temperature and density values for these types of sources show that at least polar plume bases should be visible in mm-radio. For bright points, detection in radio seems to depend on the density and loop geometry (line of sight source length) of individual sources.

Some of the radio bright regions were seen inside less bright EUV areas ('mini-coronal holes' in the coronal iron line images). The borders of these regions are now observed to be also rich in polar faculae.

Co-authors: A. Riehokainen, E. Valtaoja/Tuorla, F. Portier-Fozzani/Marseille, D. Ragaigne/Meudon

PROMINENCE OBSERVATION WITH DANJON ASTROLABE AT 11 AUGUST 1999 ECLIPSE

Petre Popescu et al.
Astronomical Institute, Romania

A solar prominence was observed at the total solar eclipse from 11 August 1999 using the Danjon astrolabe. The tehnical equipment we have used was composed by: the 100/ 3500 mm astrolabe, CCD Camera Cohu 4710, interference filter GRUBB PARSONS. The entire complex has a resolution of 0.475 arcsec/px.

Our observations started at the UT 11h12m43.178s, four minutes after the 3-rd contact, and last till 11h13m27.865s. The prominence was located on the West border of the Sun. The solar object observed by our team has two parts: the first and main part of the prominence body could be seen well until UT 11h12m 49.15s and partially till UT 11h13m18.228s, when the second feature, as an appendix, appears in the frame of view of the instrument. The second is an eruptive prominence as could be seen on SOHO observations. The analysis use a set of almost 100 images. Our results show the fine structure of the prominence and its internal dynamics.

Co-authors: Radu Popescu, Cristiana Dumitrache.

DETERMINATION OF THE NORTHERN LIMITS OF THE UMBRAL PATH OF THE 11 AUGUST 1999 ECLIPSE

Petre Popescu et al.
Astronomical Institute, Romania

Two groups of observers were positioned in two different places in Sibiu region, Romania, situated on the edge of the predicted totality band. The experiment was organized in order to point, on the Earth surface, the northern limit of the umbral path of the 11 August 1999 Eclipse. By means of visual observations, every observer measured the time of the contacts and appreciated the phase of the eclipse (partial/total). The points situated nearest to the limit partial/total of the eclipse were measured with a differential GPS. The error of the measured limit was less then 150m. The analyze contains also different results of the predicted contacts in these two points. Co-authors: Carmen Olteanu-Popoiu, Ana Pica, Alexandru Olteanu

Combined observations of active phenomena at El Leoncito solar observatory

M. G. Rovira et al.
Inst. de Astronomía y Física del Espacio, CONICET, Argentina

In the recent inaugurated German-Argentinean Solar-Observatory at El Leoncito, San Juan, Argentina, a H-alpha telescope (HASTA) and a mirror oronagraph (MICA) daily image the solar disk and the inner emission line corona. Since its installation in August,1997 MICA has been imaging the inner corona with high temporal and spatial resolution. Its field-of-view ranges from 1.05 to 2.0 solar radii above the sun centre. It can reveal the fast processes that occur in the coronal plasma. HASTA started operations on May 1998. It has a 110 mm refractor with a focal length of 165 cm and a tuneable (± 1 Å) Lyot-filter with a bandwidth of 0.3 Å. In high speed mode full frames can be taken every 2 sec. We present recent combined observations as taken by both instruments. Observations at different wavelenghts obtained with other instruments are also used. These studies tend to relate the manifestations of eruptive solar phenomena, mainly the relationship between ejective prominences and CMEs. Our results suggest that in some cases both phenomena are the consequence of a common instability.

Prominence observed with the SUMER/SOHO instrument

M. Rovira et al.
IAFE-CONICET - Argentina

We present the results obtained from analyzing SUMER/SOHO observation data of a solar prominence. The studied prominence can be characterized as having a complex structure. From the 1 hour data set, we derived characteristic frequencies in terms of intensity and velocity oscillations, for 4 transition region lines. The homogenity in the characteristic frequencies suggests the engagemente of coronal oscillations with the chromospheric structure. The presence of different types of frequencies is detected: chromospheric oscillations, intermediate periods (6min to 12min) and also long periods (25min to 51min). This result suggests that these oscillations are transmitted by the magnetic fields.

Authors: A.Costa, G.Domenech and M.Rovira *(Instituto de Astronomía y Física del Espacio - Argentina)*, K. Bocchialini and J-C.Vial *(Institut d 'Astrophysique Spatiale (IAS) - France)*

Radiance Variations of the Quiet Solar Transition Region

U. Schühle et al.
Max-Planck-Inst. für Aeronomie, Katlenburg-Lindau, Germany

Co-authors: A. Pauluhn/Bern,CH, J. Hollandt/Berlin,D, & K. Wilhelm/Katlenburg-Lindau,D

We investigate the variability of EUV emission lines during the solar minimum and the ascending phase of the present solar activity cycle. The radiances have been measured at the center of the solar disk at quiet-Sun locations using the vacuum-ultraviolet telescope-spectrograph SUMER (Solar Ultraviolet Measurements of Emitted Radiation) on the Solar and Heliospheric Observatory (SOHO). The lines that have been measured from March 1996 to the present are He I 584 Å, Mg X 609 Å and 624 Å, Ne VIII 770 Å, N V 1238 Å, and the H I Lyman continuum at 880 Å. The He I 584 Å line shows the smallest variation. Radiances of the transition region and coronal lines show an increasing trend of up to 100% after the sunspot minimum. The results indicate a global variability of the quiet solar transition region network that is related to the solar activity cycle. Our spatially resolved images allow a separation of the network and internetwork areas. A critical review is made of the long-term stability of the responsivity of the SUMER instrument.

CME Properties and Fuzzy Classification

Y. H. Tang et al.
Department of Astronomy, Nanjing University, China

In this paper, the theory and method of fuzzy classification are applied to analyse CME properties, with the use of the data in preliminary report and Solar Geophysical Data during 1979–1981, the theoretical computation for CME category is performed. According to the original data of average properties for 9 structureal classes of CME, the standardized value is obtained by average value and standard deviation. The fuzzy similitude matrix and equivalent matrix are built by use of the correlation coefficient transformation and the method of similitude coefficient, then we can divide 9 different structures into 3 categories of CME importance of major(I), middle(II), and minor(III). Halo was the most energetic, and single spike, diffuse fan CMEs were the least energetic. The quantitative properties of three importance categories are also given.

co-aurthors Z. Z. Han, C. S. Li

SUMER observations of the solar transition region. Spatial and temporal behaviour

L. Teriaca, J.G. Doyle and D. Banerjee
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In this paper we examine the spatial and temporal behaviour of the quiet Sun transition region using high resolution SUMER observations in O VI 1032. The observations are devoted to the study of the variability in the transition region and consists of four raster scans of the same area followed by a long series of spectra taken in the same position with high temporal cadence. A detailed study of the raster images allows us to differentiate the network and internetwork through Doppler shift and line width measurements. We have also identified several explosive-events like phenomena toghether with an UV bright point. We also show evidence for a possible formation of a shock front after one partcular bright point appearence. The oscillatory nature of the transition region is finally investigated using the wavelet analysis and particular attention has been paid to the effect due to the occurrence of explosive events.

Mass and Energy Flows in the Solar Transition Region and Corona

A.R. Winebarger et al.
Harvard-Smithsonian Center for Astrophysics

In this poster, we investigate the mass and energy flows in the transition region and corona. We begin by calculating the energy flux associated with "explosive events" observed with the SUMER instrument at various transition region temperatures. We find that the distribution of events as a function of energy is well represented by a power-law function with an index of approximately 2.8 indicating that very small events could release the energy required to heat the corona. Next we consider TRACE observations of intermittent flows in the corona above an active region. From the observations, we determine the frequency, duration, and bulk velocities associated with these events and conjecture that they are a result of magnetic reconnection occurring in the transition region and are therefore associated with explosive events. The TRACE observations further support that energy released during explosive events could be significant in the mass and energy balance of the solar transition region and corona.

A semi-empirical model for a solar coronal hole

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On the basis of UVCS observations of the Lyman alpha and O VI doublet lines at 1031.9Å and 1037.6Å, we developed a semi-empirical model for a solar coronal hole observed on 5-11 August 1996. Making use of the collisional part of the O VI line at 1037.6Å we estimated the spatial distribution of the electron density for the North-East sector of the solar corona, at heliocentric distances between 1.5 and 3.0 R$\odot$. Assuming a magnetic field geometry, from the mass flux conservation and the derived electron densities, we determined the expansion velocity of the solar wind. Kinetic temperatures are given by the profiles of the Lyman alpha and O VI lines, and electron temperatures have been adopted a priori from values given in the literature. We tested the reliability of our results by comparing the observed Lymanα emission with that predicted by our model. We found that, in agreement with observations, there is no sensible variation of the Lymanα emission with latitude in the coronal hole, at least within the heliocentric distances between 1.5 and 3.0 R$\odot$. The model has also been used to derive the O VI line intensities.

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TRACE Emission Heights Estimated From TRACE Limb Observations

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While TRACE data have provided us much information of transition region and coronal structures, many TRACE data users would like to have a knowledge of emission heights of TRACE bands. By analyzing TRACE limb observations, we give an average estimation of TRACE bands for different features like quiet Sun regions, active regions and coronal holes etc. Average emission heights over the limb are also discussed. Previous equator-to-pole height variation is further confirmed by TRACE data when averaging quiet Sun regions. If averaging for all flux, a reverse equator-to-pole height variation is shown.

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A Comparison of
Coordinated TRACE and EIT Observations

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It is well know that in order to get a temperature or EM map from EUV observation of TRACE or EIT, we have to assume a certain coronal abundances and ionization equilibrium as input. Using different coronal abundances and ionization equilbirium assumption, we will get different temperature or EM maps. This will certainly limit our understanding of the true variation of temperature or EM maps.

Using coordinated TRACE and EIT observation, we will try to discuss which pair of coronal abundances and ionization equilibrium assumption will give the least difference of temperature and EM maps. This pair may be thought as "best" input for coronal abundances and ionization equilibrium assumption, and the difference between temperature or EM maps from coordinated TRACE and EIT observation may be regarded as an estimation of the accuarcy of temperature or EM maps using this kind of method.

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Helical Magnetic Structure of White Light Polar Plumes

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We describe the fine structure of white light polar plumes observed by SOHO/LASCO C2coronagraph. The evolving helical structures of different scales are clearly seen on the specifically processed images (the processing reveals the faint contrast objects). The observed structures trace the magnetic field lines, sothe electric currents flow along the axis of the plumes. The MHD model of a plume takinginto account field-aligned electric currents is developed. The model permits to understand the existence of high-density plasma inside the plume due to the balance between the Ampere force and transversal pressure gradient. Consequences for the solar wind acceleration process and for the structure of heliospheric current circuit are discussed.

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Mechanisms for Coronal Mass Supply by Evaporative Micro-Events

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There is extensive evidence from SoHO and other data that "micro-events" play an important role in sustaining at least some components of the solar corona. These are often termed coronal micro-"heating events" though a major part of their role is feeding coronal loops through chromospheric evaporation. We consider what can be learnt from these data concerning the energy release and transport mechanisms driving the evaporation, including thermal conduction and fast particles, and what model constraints are available from other data (such as hard X-rays and radio events). We conclude, from one large event and the statistics of many small ones, that conductive evaporation alone does not fit observations and that fast particles or some other nonthermal driver must be involved. As well as the problem of single loop events, we consider the global implications for supply of the corona and wind.

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Long-term variations in the Extreme-UV corona: the EIT/SOHO perspective

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Since the start of the SOHO mission, EIT offered a global view of the extreme ultraviolet corona constinuously over the whole rising phase of the solar activity cycle. Such a long-duration data serie is unprecedented. We present here the current results of an ongoing investigation of the entire EIT data set. In this process, numerous classes of magnetic regions of all sizes (active regions, coronal holes, bright points, plumes, transition region network, filaments) as well as many different classes of dynamic events (CME's, flares, jets, blinkers, macrospicules) will be identified in EIT images made in its four bandpasses. The changes in the class properties (location, size, area, topology, lifetime, integrated flux) or in the relationship between different object classes can then be monitored over the fast rise of magnetic activity towards the current maximum. We describe here the image processing techniques developed for this search as well as early results.

The Temperature of The Extended Solar Corona

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We use the *Coronal Diagnostic Spectrometer* instrument on board the *Solar and Heliospheric Observatory* to analyse coronal helmet streamer structures observed close to the solar minimum / maximum on the 1996 July 8 / 1999 July 4-5th. The radial variation of peak electron temperature is extracted out to 2 solar radii. These are found to agree well with Yohkoh observations close to the solar maximum, but are found to be reduced by around half a million close to the solar minimum. Extrapolations of the photospheric field observations of MDI are used to aid interpreted with regard to the energy depostion in the low corona and solar wind.

Non-ideal MHD effects for magnetic flux tubes in the photosphere

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Magnetic flux tubes reaching from the solar convective zone into the chromosphere have to pass through the relatively cool photosphere. The photospheric plasma has a degree of ionization of less than 0.01 % and a temperature of about 4200 K. It thus forms a non-ideal region with non-vanishing resistivity enclosed between the highly ideal sub-photospheric and chromospheric plasma. It is shown that stationary MHD-equilibria of magnetic flux tubes which pass through this region require an inflow of photospheric material into the flux tube and a deviation from iso-rotation along the tube axis. This means that there is a difference in angular velocity of the plasma flow inside the tube below and above the non-ideal region. Both effects increase with decreasing cross section of the tube. Although for characteristic parameters of thick flux tubes the effect is negligible, the scaling law indicates its importance for small-scale structures. The relevance of the inflow of photospheric material for the expansion of flux tubes above the photosphere is discussed, as well as the implications of the deviation from iso-rotation for the commonly used assumption of flux tubes being frozen in the photospheric plasma.

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Parametric instability of a broad-band Alfvén wave: nonlinear evolution and saturation.

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The nonlinear evolution of the parametric instability of a finite amplitude Alfvén wave is studied in a one-dimensional geometry. The linear stage of this instability had been examined by Malara and Velli, (Phys. Plasmas **3**, 4427 (1996)), who showed that even a nonmonochromatic broad-band wave is unstable. Here, the time evolution is followed up to saturation, by numerically integrating the full set of MHD equations. Several configurations of the Alfvénic pump wave, as well as different values of the plasma β are examined. The saturation level of the instability does not depend on the spectral width of the pump wave, but it depends on the value of β. For $\beta \leq 0.5$ the final state is characterized by a cross-helicity ~ 0 and a moderate level of density fluctuations: the Alfvénic correlation of the initial wave is completely destroyed, even for a broad-band initial spectrum. For $\beta = 1$ the final cross-helicity is closer to that of the initial wave, indicating a lower saturation level. The parametric process appears to be nonlocal in the wavevector space also in the nonmonochromatic case, this feature becoming more relevant with increasing β. These results are relevant to the problem of the cross-helicity decay observed in solar wind at high latitudes.

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AN ANALYSIS OF SOLAR DATA IN THE SOFT X-RAY AND OPTICAL WAVELENGTHS

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We present an analysis of soft x-ray and optical solar data. We perform a statistical study on data from the SMM satellite, the GOES mission and ground based optical data.

There is strong evidence to support previous flare clasification schemes based on the strong distribution of event durations, maximum intensities and event assymetries. There is some evidence to support the theory of coronal heating by microflares.

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Variation of H I Ly-α and O VI 103.2 nm in the Solar Corona from 1996 to 2000

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UVCS/SOHO measurements of H I Ly-α and O VI 103.2 nm intensities in the solar corona have been made from 1996 to the present, thus spanning the rising phase of cycle 23. At solar minimum, the corona consisted of large coronal holes at the poles and quiescent streamers at the equator. During the ascending phase of the cycle, the corona presented high latitude streamers. Finally, recent observations as the Sun approached solar maximum have shown the presence of coronal holes at the equator and streamers at the poles. Our observations provide descriptions of the various coronal structures that existed over the rising phase of the solar cycle. We compare spectral line intensities of quiescent equatorial streamers that occurred at solar minimum to those of high latitude and polar streamers observed toward solar maximum. We also compare spectral line intensities of solar minimum polar coronal holes to those of equatorial coronal holes present at solar maximum. We discuss how these results are related to the plasma properties.

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Coronal hole properties observed with SUMER and CDS

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We look for clues to the formation process of the fast solar wind by analysing the behaviour of plasma inside coronal holes.

For this purpose, we use ultra-violet emission spectra recorded by SUMER and CDS. The use of those two instruments extends the formation temperature range of the spectral line sample analysed and allows us to carry out interesting comparisons.

We analyse parameters like intensity, Doppler shift and line width from data obtained in polar coronal holes and compare them with results from the quiet Sun.

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An observational test for coronal heating models

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We study the evolution of the emissivity and heating correlated with magnetic observables of an active region from its birth throughout its decay during seven solar rotations (July-Dec. 1996). Taking one "snapshot" per rotation at each consecutive central meridian passage of the AR, outside the time of flares, we analyse multi-wavelength and multi-instrument data obtained from SOHO (MDI, EIT, CDS and SUMER), Yohkoh (SXT), GOES, SOLSTICE and 10.7 cm radio data from DRAO, Canada. We utilise our results to test the validity of coronal heating models. We find that models which are based on the dissipation of stressed, current-carrying magnetic fields are in better agreement with the observations than the models which attribute coronal heating to the dissipation of MHD waves.

Scaling Laws for a Nanoflare Heated Solar Corona

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The concept that solar corona is heated by numerous small flare-like events dubbed "nanoflares" is considered. The hot corona is viewed as an ensemble of high-temperature elemental magnetic filaments created within the coronal magnetic field by randomly distributed impulsive heating events. It is shown that it allows to predict various signatures of X-ray coroanl loops without specifying details of the heating process. In particular, dependence of the temperature, filling factor and emission measure on the length of the loop and strength of the coronal magnetic field is derived. The obtained scaling laws fit reasonably with observational data.

Nonlinear Damping of Fast Waves and Plasma Heating in the Solar Corona

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Fast waves can be excited in the corona by compressional perturbations of magnetic field lines which are anchored into the dense convective zone and displaced by the plasma motions there. The consequent linear dissipation of fast waves in the resonant layers can contribute to coronal heating. A difficulty of this dissipation mechanism is that the setup time of the linear resonance (the time required for the creation of sufficiently short length-scales) is long compared to the sub-minute variations in the coronal heating process. This suggests a more effective mechanism for the structurization of waves in the solar corona. We propose a new, nonlinear mechanism for the dissipation of fast waves in the corona. In the framework of two-fluid MHD we show that fast waves are nonlinearly coupled to the kinetic Alfvén waves - Alfvén waves with short wavelengths across B_0, background magnetic field. The nonlinear coupling is effective for the amplitudes of the launched fast waves in the range 0.01 to 0.03 for B/B_0 (B is wave magnetic field), implied by spectroscopic observations. As the excited AWs have very short wavelengths, they are damped almost immediatelly by the linear kinetic or collisional dissipation. Therefore, the resulting plasma heating has the overall timescale of the order of the characteristic time of nonlinear interaction, which can easily be in the sub-minute range.

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Turbulent heating and nonthermal broadening in solar flares

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Synchronous *Yohkoh* observations of soft X-ray nonthermal line broadening and hard X-ray emission in solar flares suggest that both the nonthermal broadening and the plasma heating are due to plasma turbulence created in the energy release. We develop the model of a flaring loop energized by the turbulence of kinetic Alfvén waves (KAWs) excited by reconnection outflow.

Spectral dynamics and mechanisms for the interruption of spectral energy fluxes in the KAW turbulence are investigated. These processes determine the nonthermal broadening in flares and are important for the selective heating of plasma species and for the acceleration of particles to high energies. Depending on the gas/magnetic pressure ratio, the ion Landau damping or induced ion scattering of KAWs comes into play, and the turbulence dissipation gives rise to a preferable heating of ions or electrons.

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Collaborative VLA, SOHO and TRACE Observations of Nonthermal Energy Release in the Corona

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Very Large Array (VLA) observations of the Sun at 91 and 400 cm have been used to study the radio signatures of evolving EUV loops and coronal mass ejections (CMEs) detected by SOHO (EIT, LASCO) and TRACE. These investigations provide information about the complex and evolving magnetic environment of the inner solar corona and on the coronal signatures of nonthermal particle acceleration at different heights. On one day, our VLA observations show the onset of intense 91 and 400 cm burst emission during an X1 soft X-ray burst detected by Yohkoh and prior to a CME observed by LASCO. VLA snapshot maps were used to specify the spatial and temporal evolution of the radio sources, thereby providng information about the nonthermal electrons and the coronal structure of the magnetic fields involved. VLA observations were also used to study the spatial and temporal variations of low brightness temperature "microbursts" (400 cm) in coordination with EIT and TRACE. One microburst was contained within two sources separated by $\approx 0.7 R_\odot$ indicating that the emitting beams had access to widely-divergent magnetic field lines originating at a common site of particle acceleration. In most cases, the 400 cm microbursts were not associated with detectable changes in underlying EUV loops, suggesting that the particles that produce the radio bursts were independently accelerated in the middle corona, perhaps as the result of some quasi-continuous large scale process of energy release.

Effect of Solar Mass Ejections on Interplanetary Scintillations Observations

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Method of Interplanetary Scintillations (IPS) has been widely used to study interplanetary activity. IPS measurment provides an estimate of the density and velocity of the solar wind along the line of sight. This paper presents a model for plasma scattering by the multicomponent and time-varying interplanetary medium which we applied to the high-time resolution IPS data acquired during the 22nd Solar Maximum. We studied the effect of Solar Mass Ejections (SMEs) on IPS observations under various conditions. The model study suggests 1. Fast moving IPC are easier to detect closer to the sun, 2. Observations of IPCs at higher radio-frequencies are desirable and 3. Geometry of SME plays an important role in its early detection. These results would help planning of IPS observations to detect SMEs and monitor Space weather.

Isotopic fractionation in slow and coronal hole associated solar wind

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Solar matter is a geochemical reference for the original composition of the protosolar nebula from which the solar system formed. Therefore, the Sun represents the least biased sample of interstellar matter and the solar wind provides the most comprehensive source of information about solar isotopic abundance. From in situ measurements of the solar wind one obtains informations on the present-day isotopic composition of the outer convective zone of the Sun. The flow dynamic of the solar wind is determined by the magnetic topology of the flux tubes and is different for slow and fast solar wind, respectively. The slow solar wind originates from closed field line regions whereas the high speed solar wind is emitted from open flux tubes in coronal holes. Data from the Mass Time-of-Flight spectrometers MTOF and CTOF on board SOHO have been accumulated for time periods in which coronal hole and non-coronal hole type plasma has been detected by using different methods in order to determine the abundance ratios of magnesium isotopes in these two different source regions of the solar wind. The results as well as limits will be discussed in the context of extisting theories.

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Solar Orbiter — A High Resolution Mission to the Sun and Inner Helisophere

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The scientific rationale of the Solar Orbiter (SO) is to provide, at high spatial and temporal resolution, observations of the solar atmosphere and unexplored inner heliosphere. The most interesting and novel observations will be made in the almost heliosynchronous segments of the orbits at heliocentric distances near 45 $R_\odot$ and out-of-ecliptic at the highest heliographic latitudes of 38 degrees. The SO will achieve its many and varied aims with a suite of small and innovative instruments through a clever choice of orbits. The first near-Sun interplanetary measurements together with concurrent remote observations of the Sun will permit us to determine and understand, through correlative studies, the characteristics of the solar wind and energetic particles in close linkage with the plasma and radiation conditions in their source regions on the Sun. The SO will, during the high-latitude orbital passes, provide the first observations of the Sun's polar regions as seen from outside the ecliptic and also measure the magnetic field at the poles.

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Propagation of high energy electrons in solar plasma

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Recently it was discovered (Mel'nik,1995; Mel'nik and Kontar, 1998; Mel'nik et al.,1999) that high energy electrons propagate in plasma in the form of a new nonlinear object, beam-plasma structure. Its main properties, like the invariable form, the constant velocity, the capacity to move at large distances without any energy loss, and interaction with each other, are identical to those for another well-known nonlinear object, soliton. The beam-plasma structure is a compound object involving electrons and Langmuir waves. The physical cause of the structure formation is the generation of Langmuir waves at the front of the beam-plasma structure and absorption of these waves at the back of it. The beam-plasma structure is a source of emission because of plasma mechanism. The rigorous expression for the emission intensity of beam-plasma structure that defined by high energy electron parameters (density, velocity) has been found. This gives an opportunity both to understand the fenomenon of burst-like character of nonthermal radio emission and to receive the information about the state of the coronal plasma. The obtained results are applied to the properties of Type III bursts.

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Improved analysis of COMPTEL solar neutron data, with application to the 15 June 1991 flare

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Direct solar flare neutrons are a valuable diagnostic of high-energy ion acceleration in these events, and COMPTEL improves over all previous cosmic neutron detectors in its capacity for neutron energy measurement. Previous studies of COMPTEL neutron data have worked with an incomplete model of the instrumental response, applying energy-by-energy detection efficiences. Ignoring off-diagonal elements of the response matrix in this way essentially underestimates the overall detector efficiency. Here we employ statistical regularisation techniques with the full (Monte Carlo simulation derived) response matrix to produce improved estimates of neutron numbers and energy distribution. These techniques are applied to data from the well-observed 15 June 1991 flare. We find that the data imply an incident neutron flux 73% of the previously inferred value. Implications for the picture of primary ion acceleration in this flare are briefly discussed.

Shock drift electron acceleration and pitch angle scattering

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Spacecraft measurements of energetic electrons in the vicinity of the Earth's bow shock and interplanetary shocks are analyzed and compared with theoretical calculations. It is shown that shock drift acceleration of electrons is very modified by an additional process, namely by strong pitch angle scattering. Calculations including this effect will be presented and compared with observations.

Observation and study of interplanetry scintillation with the Miyun telescope

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We present the preliminary results of observation and study of interplanetry scintillation with the Miyun telescope at Beijing Astronomical Observatory. The properties of the telescope, observing parameters, and data reduction are described in this contribution. The telescope is used daily to trace some radio sources with time scale of several hours a day to measure the velocity variation of solar wind at a position which is relatively fixed to the Sun during each observation. Some observation examples and preliminary analysis are also given.

HST Observations of Heliospheric and Astrospheric Lyα Absorption Toward the α Cen System

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Charge exchange processes create a population of heated neutral hydrogen gas throughout the heliosphere. This material produces a detectable absorption signature in the Lyα lines of nearby stars with low interstellar column densities. Such spectra have therefore been used to study the properties of neutral hydrogen in the outer heliosphere, and also to detect analogous astrospheric hydrogen surrounding other stars. The first detection of heliospheric Lyα absorption was from observations of α Cen A and B made in 1995 with the GHRS instrument on board the Hubble Space Telescope. The heliospheric material produces excess absorption on the red side of the interstellar absorption. Excess absorption also exists on the blue side, which is believed to be due to astrospheric material around the two stars. On 1999 February 12, α Cen A was observed again by the STIS instrument, which replaced GHRS in 1997; and on 2000 May 8, α Cen's distant companion star Proxima Cen was also observed by STIS. We compare the GHRS and STIS data in order to search for variations in the heliospheric absorption that would indicate structural changes in the heliosphere, possibly induced by solar wind variability associated with the Sun's activity cycle. We also search for analogous changes in α Cen's astrosphere, and we compare the astrospheric absorption of α Cen with that of Proxima Cen as a way of comparing the stellar wind properties of these very different stars.